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TABLE OF CONTENTS

	Page
LEADING ARTICLES:	
Flumes for Transporting Logs, Lumber and Sugar Cane (illustrated)	501
Single Generating Units in Power Plants; H. S. Knowlton	503
Pier and Bulkhead Construction in New York Harbor (illustrated); S. W. Hoag, Jr.	503
The International Railway Congress	511
Social and Entertainment Features of the International Railway Congress	517
Annual Convention of the American Water-Works Association	521
The Duluth Ferry Bridge in Operation	522
EDITORIAL	519
The Success of the American Railway Appliance Exhibition at Washington—Plans for Another Exhibition of Railway Appliances—Exhibits in Connection with Meetings of Technical Societies.	
Light Railway Problems in America	519
LETTERS TO THE EDITOR.—Pressure Against Hand Railings; Fr. V. Meyer, C. E.—Design of the Cross-Section of a Street Having Curbs at Different Elevations (illustrated); Holland Wheeler—Eckel's Formula Applied to Irregular Cross-Section Areas Without Plotting (illustrated); J. A. Macdonald—Further Discussion of a Court Decision Relating to the Subdivision of Sections of Land; F. Hodgman—Notes and Queries	520, 521
ENGINEERING NEWS OF THE WEEK	523
PERSONALS	524
ENGINEERING SOCIETIES	524

FLUMES FOR TRANSPORTING LOGS, LUMBER AND SUGAR CANE.

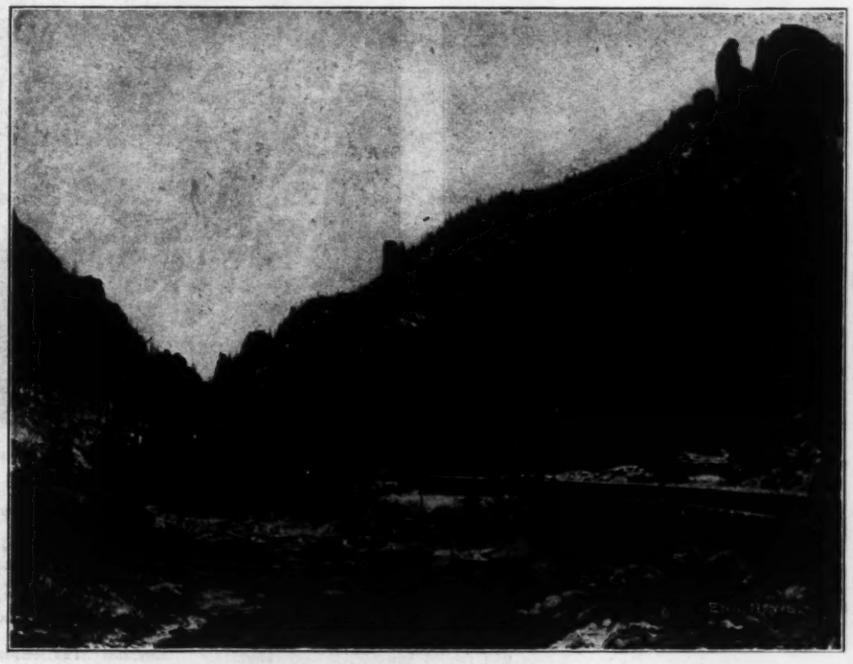
In our issue of Feb. 9 an illustrated article gave data on this subject, and the request was made that further information be submitted by our readers. We have received four letters and a number of excellent photographs of flume construction. The photographs herewith reproduced have been sent by Mr. Hermann von Schrenk, of the U. S. Department of Agriculture. The description of the flume that the photographs illustrate is given by Mr. von Schrenk as follows:

One of the most interesting flumes for transporting timber was constructed some years ago in the Big Horn Mountains of Wyoming, for the purpose of bringing mine props, ties and lumber from the mountains to the tracks of the Burlington Railroad. This flume was constructed for J. H. McShane & Co., of Omaha, Neb., by M. G. Swan, Constructing Engineer, and is operated by them at the present time. The flume is 12 miles in length, and traverses a very broken and rugged country, as indicated in the photographs.

There are a number of extremely interesting features from an engineering standpoint along the line of the flume, notably the "dry chute" at the end of Tie Creek, where there is a fall of 700 ft. in less than 2,000. The ties are controlled in their flight through this chute by a system of check poles and a plunge into a pond at the bottom.

There are two tunnels in the course of the flume, one 320 ft. and the other 90 ft. long, and a bridge across a deep gulch 400 ft. long and 90 ft. above the bottom of the gulch. The total fall from the head of the flume to the mouth, where the ties enter into the river, is about 4,000 ft.

The construction of this flume was a matter of considerable expense. Four miles, near the head of this flume, cost $35,000, and five miles of new extension cost $5,000 per mile. About 2,000 to 2,500 ties can be run through the flume in a day of ten hours. The particular feature of interest in connection with the flume is the ease and rapidity with which timbers are transported from high elevations in the mountains to the railroad, through a country which presents almost insurmountable difficulties to transportation methods, other than the flume.



FLUME FOR RAILWAY TIES AT THE ENTRANCE OF THE UPPER CANYON, BIG HORN MOUNTAINS, WYOMING.

Mr. S. G. Walker, C. E., of Greenfield, Mass., gives the following interesting description of a flume built for the transportation of sugar cane. The cost data and the remarks about gradients are particularly valuable.

Flumes for the transportation of sugar-cane, from the fields to the mills, have been in use in the Hawaiian Islands for many years; and, although conditions on any single plantation are not such as to bring them into direct competition with railroads, in a manner such as to permit of a close comparison of economy to be drawn, it is generally conceded that flumes, when practicable, are the more economical in original construction, maintenance and operation, and in very many instances have been employed where railroad location was out of the question. While not as flexible in their adaptation to certain demands of traffic, they are especially valuable where it is to be almost entirely on a down grade, as is the case on most sugar plantations.

The writer, having in charge the design and installation of the greater part of the cane transportation facilities for the Olaa Sugar Co., Ltd., one of the largest sugar estates in the Islands, had occasion to examine into the merits of the various systems in use for that purpose, with reference to their adaptability to the existing local conditions, and although flumes had not up to that time been employed on so large a scale, and it was questioned by many whether it could be successfully accomplished, on account of lower grades than had previously been considered essential to their proper operation, their adoption was finally decided upon. An important consideration bearing on the decision, aside from those above mentioned, was rapidity of installation, as, after the lines had been surveyed, work could be commenced simultaneously in several localities and the system pushed to rapid completion; furthermore, about 5,000,000 gallons per 24 hours were needed for the most efficient operation of the mill, and as the nearest available supply of that quantity was at a point about ten miles distant, and at 2,000 ft. elevation, while the elevation of the mill was only about 200 ft. above sea level, it was clearly economy to introduce the water to the plantation at as high an elevation as feasible, charging it with transportation duties while on its journey to the mill.

Accordingly a water-head was established by driving some 2,500 ft. of tunnels, intercepting underground streams, until a quantity of water had been secured which was deemed sufficient for the demands, when a flume was constructed, 46,000 ft. long, on a grade of 0.002, the section being rectangular, with a 32-in. bottom and 26-in. side; the material for the boxes, 1½-in. planed redwood plank, and for the trestling, 3 × 4-in. redwood, the bents being spaced 6⅔ ft. apart, and properly braced. The line in profile ranged from 10 ft. in cut to 35 ft. on trestle, but as it was constructed by day labor no account was kept of quantities. The sharpest curves employed were 10° and no attempt was made toward accurately fitting the boxes to the curve between joints, or super-elevation of the outside, as it was deemed that, with the comparatively slow velocity to be induced, the benefit to be derived from such refinements would be more than nullified by subsequent, uneven settlement, which the event proved to be true.

The line being through the forest for nearly its entire length, and the nearest road distant about three-fourths of a mile, a road was first constructed to intersect the line at a point about 4,000 ft. from the water-head, which, being completed, the haul for the material from the wharves was about eight miles. Construction was commenced at the end of this road, the lumber being handled and distributed along the line of the flume by means of broad-wheeled wooden "dollies" traveling on the planking, which had been laid upon the finished trestling for that purpose as the work progressed. When the water-head had been reached in this manner the boxes were built in place and the water admitted, after which the materials for the remainder of the flume below the road, together with camp supplies, etc., were transported and distributed as needed in the flume itself. For fluming, the lumber was tacked together in rafts, the other materials being piled on these rafts to prevent wetting. As the widest plank used in the flume was 20 ins., no difficulty was experienced in the passage of these rafts around the curves, and as a considerable saving in cost of hauling and distributing by this means became evident, the materials for several other flumes on the plantation were sent over this route, so that eventually the transportation of lumber alone in this flume amounted to several million feet, without apparent injury to the flume; so that, under similar conditions, it would be probably safe to assume the life of a flume to depend upon its weathering qualities under existing climatic conditions, rather than upon the quantity of material transported, provided there were a sufficient quantity of water at all times to float the material free from the bottom of the flume.

The cane flumes on the plantation are V-shaped in section, with vertical side-boards, which are added to avoid loss of water by overflowing behind the loads—a very important feature in this system of transportation in its effect upon the number of feeders required. In the standard size, the V was composed of 14-in. plank 1½ ins. thick, the side-board being 6 ins. in height, although as

large as an 18-in. V, with a 12-in. side-board, has been employed where very heavy traffic was expected; and this section, with a flow of about 8 cu. ft. per second, has been found capable of delivering at the rate of 60 tons of cane per hour, the grade being 0.026. Large quantities of firewood in 4-ft. lengths have at times been transported in these flumes when not in use for cane; but as the grades range from 0.01 to 0.04, or in some individual cases even higher, the velocities are correspondingly high, and as the material is in actual contact with the flume bottom the wear on the flume is very appreciable; in fact, a flume designed to carry wood or any such substance continually would need to be lined with, or be constructed of, sheet steel, to be economical if operated on the above-mentioned or steeper grades.

With common labor at 75 cts. per day and carpenters at $1.50; lumber, $30 per M., and nails $6 per cwt., the costs of the above water flume, distributed, per linear foot, were as follows: Lumber, 55¾ cts.; hauling, 10¼ cts.; nails, 3¼ cts.; clearing (a strip of forest 150 ft. wide, together with excavations on the line), 16¾ cts.; carpentering, 18¼ cts.; board for men, 9¾ cts.; a total of $1.14 per linear foot. On the same basis, the average costs of seven flumes, aggregating about 16 miles in length, were as follows: Lumber, 25½ cts.; hauling, 2¾ cts.; nails, 1½ cts.; clearing (excavations), 3¾ cts.; carpentering, 8 cts.; a total of 0.415 cts. per linear foot.

The average life of a flume is estimated to be about ten years, if kept in proper repair and never allowed to dry out, but under such varied conditions of operation there are no data available whereon to form an estimate based upon the amount of work performed.

The experience of the writer is that flumes cannot ordinarily be employed for transportation to advantage with a flow of less than about 4 cu. ft. per second, and with that quantity the best results are obtainable from both the standpoints of life of flume and condition of material at delivery, with low grades and a large flume section, provided that the design is properly modified to conform to the demands of the case in hand.

Mr. Charles H. Gillett, of Appleton, Wis., gives the following facts relative to a long flume built 20 years ago, in Wisconsin, and still in operation:

A wooden flume for transporting logs from a dam near the foot of Long lake along the creek bottom of a crooked ravine to Drummond lake, was built about 20 years ago by the Rust-Owen Lumber Co., at Drummond, Wis., and the same is still in use.

The length is only about 1,500 ft. It has a flat bottom, 2 ft. in width, with 4 ft. sides inclined about 35° from the vertical—practically the same plan as shown in Fig. 3, Feb. 9, 1905, p. 133, Engineering News. Some of the curves have a radius not greater than 100 ft., and the grades range from about 7% at the upper end to less than 1% near the lower end. However, the velocity appears to be quite uniform, and the flume suffers very little wear at sharp curves from the passing of heavy logs, it is also impossible to overcrowd the capacity of the flume with logs passing a 4-ft. gate in the dam.

Mr. F. Drummond, of Drummond, Wis., designed and built the flume.

The following interesting letter from an engineer indicates the difficulties that beset the man seeking information on flume construction:

Your reference to the letter of Mr. Weeks, in the issue of Feb. 9, has interested me. In 1892 I was looking for just such information, for a project was on foot to build a long lumber flume and there was a bare possibility that I might get the job. I was then residing in California, a State that has a great many lumber flumes. My first step was to send a letter to each county surveyor, or to some prominent man in each county, asking for information about lumber flumes in that county. Although a stamped addressed envelope was enclosed, only 9 men replied. California has 58 counties (52 and a joker) and I wrote about 75 letters.

The nine men who replied however, told me about six flumes they knew of, and I wrote letters to the companies without receiving any replies. A second lot of letters brought back four curt replies to the effect that the company was not giving away information that had cost them money to procure. A fifth letter very courteously said that they had no information in the office as the building of the flume had been left to the boss carpenter and a civil engineer by the name of Graham, who lived at or near Healdsburg. The sixth reply gave me the length of the flume, and contained an invitation to call at the office and see photographs. When I called I was treated nicely, and was told that somehow within the past few weeks there had been such an avalanche of letters for information on flumes the company was getting weary. As all the companies had offices in San Francisco I called on all and found the same conditions. They told me that every unemployed surveyor and boss carpenter in San Francisco was figuring on getting a job from the lumber people I was figuring with, and each claimed to know it all but was in the meantime trying to get up to date information.

So I wrote letters of inquiry to about 20 papers in the state containing a request for other papers to copy. Then I subscribed to a Press Clipping Bureau and waited. The returns came in. Most of the clippings (at 5 cts. p were of my letters, which were copied extensively. A men wrote, however, about building lumber flumes, with these men I conducted more correspondence.

I visited the flume of the Fresno Lumber Company Fresno County and of the Shasta Lumber Company in T hama County which flume ends at Red Bluff. Also seve shorter ones.

I remember reading in Engineering News some ye ago, an account of a lumber flume crossing a ravine o suspension bridge, and of the vibrations being so gre when the water commenced to flow that the water did cross the bridge, and it was necessary to put in a ste ening truss.

The illustrations you gave this week give a very g idea of the appearance of a lumber flume and the man of constructing the trestle work.

The flumes are always V-shaped. This is for three re sons: 1st, for economy of lumber; 2d, for economy of wa ter; and, 3d, to lessen the liability of the lumber stick ing.

The V is not always true, as it is common to place a 2 × 4 or 2 × 6 along the bottom to nail the sides to. When the grade is light the lumber floats in the water. On steep grades there is only a skin of water underneath, and in the case of heavy timbers the water piles up behind and pushes them ahead, the skin simply acting as a lubricant. The employees sometimes ride to town in what is called a boat consisting of two boards with a rear end piece fitting the flume. There is no bow, and the water piling behind pushes the boat ahead. Shooting the chutes "is not in it" with the sensation of riding in one. I took one ride. No more for me. In other flumes a boat of more box-like form is used.

Alongside the flume is often put a foot board, as is shown in your illustrations.

The grade can be anything, but the vertical curves at each end must be carefully figured and constructed. Few flumes are built by civil engineers. The greater number are built by carpenters who have had considerable experience in such work. In the flumes I saw, it seemed to me, the ones that had been built after the plans of an engineer were smoother; that is, more workmanlike in appearance. It may have been a prejudice in favor of the profession.

The curvature is an important item. The least curve depends upon the length of the timbers to be floated, together with their dimensions. Disasters on flumes laid out without an engineer were frequent, and the adjustment of the curves was in many cases costly. If a piece sticks on a day when there is a good movement of lumber,

Men Lowered by Ropes, 800 ft. from the Top of the Canyon.

Flume Trestle, 90 ft. High.

DIFFICULT FLUME CONSTRUCTION IN THE BIG HORN MOUNTAINS, WYOMING.

every pie[illegible] following will be thrown overboard. I saw one place wh[illegible] the flume skirted a cliff at a height of fully 200 ft. [illegible]ve the foot. One day a piece of timber stuck, and over [illegible],000 ft. B. M. jumped out before the man at the low[illegible] end noticed the cessation of flow and telephoned [illegible] ask the upper end of the line why they had stopped [illegible]ding. Upon receiving his message they stopped deliver[illegible]nd went along the flume to search for the trouble. T[illegible]umber when found was good for kindling wood.

FLUME PASSING THROUGH A SHORT TUNNEL AND ENTERING A LONG TUNNEL.

Sometimes, though very rarely, the flumes are used to transport sawed dimension stuff. Generally they transport logs or railroad ties. It can readily be seen that in the case of railroad ties almost any curve will do, and the same can be said for flumes taking shingle butts and shakes. For longer pieces, however, great care must be used.

I learned quite a lot about lumber flumes, and saw a large number of them; I also talked with a great many men who had put them up. Another man got the job I was after however. He was a "practical" man and a carpenter, and therefore much preferred to a "theorist" and an engineer.

SINGLE GENERATING UNITS IN POWER PLANTS.

By H. S. Knowlton.*

A number of new power plants have lately been completed which are each noteworthy in the adoption of but a single generating unit. As might be guessed, these are all isolated plants; in central station practice the great importance of reserve power is universally appreciated. Yet it is difficult to see why reserve power of some sort is not relatively as important outside the central station field as within it. One of the plants in question supplies power to a large carpet mill, another caters to the needs of a wholesale coffee grinding house, and a third drives the machinery and furnishes electric heat and light in a laundry. Such a departure as this from the usual plan of installing at least two units or a single unit with a storage battery or breakdown connection with the local central station circuits deserves comment.

Evidently the purchasers in the different instances felt assured that modern electrical and steam machinery is in high degree reliable, else they would not have taken the chances of serious delay, in case of breakdown, with so little thought of the consequences. Such confidence is indeed gratifying to those of us who have seen power plant machinery develop from the rather crude types of the late eighties and early nineties to the superb mechanical productions of to-day, but it is a grave question if good practice is served by such extreme faith in the ability of engines and dynamos to operate continuously in hard daily service—and the service ought to be hard, if a plant is to be an economical factor in intensive production.

To base the continuity of business in a large establishment upon the faithful performance of a single machine is certainly to assume risks that could be greatly reduced by a subdivision of units on a proper basis. The tendency to do this is not, however, difficult to explain. In some cases so much money has been expended upon the building and fixtures of a new establishment before the power equipment is installed or even definitely selected that there is little left for the purchase of reserve machinery. The owners find that the cost of their new establishment is going to exceed their estimates for one reason or another, and the tendency to economize in equipment seems almost irresistible. This is exactly where the consulting engineer's advice is most needed, for the determination of the number and size of units is a problem for the specialist. The cost of a single generating unit of a given capacity is generally less than the cost of two machines of half the size, and the efficiency of the large generator and the steam economy of the large engine are pretty sure to be better than the figures guaranteed for the smaller units. The additional cost is frequently further increased, however, if each of the subdivided power units is selected with an overload capacity sufficient to enable it to carry the total load for a couple of hours in tiding over the effects of a breakdown. It is consequently not strange that owners should fail to realize the necessity of paying for reserve capacity.

A few experiences in the way of shut downs, however, are usually sufficient to illuminate the situation. As the load varies considerably in isolated plants at different hours of the day, when power and lighting current are supplied, economy of operation is better secured through the adoption of at least one smaller unit which will work at its best rate of steam consumption where the load upon the plant is light. To this end many isolated plants in office buildings, hotels, etc., are now installed in three units, two of which are equal in rating, with the third of smaller capacity.

As the labor cost of producing a manufactured article is often 40 or 50 per cent. of the total expense of putting it on the market it is worth while to insure continuous operation in the work shop. Unless very unusual reasons appear, it would seem that the use of a single generating unit only, in an isolated plant, is not good practice. When an emergency connection with the local central station can be had at a reasonable price the problem is greatly simplified.

*Newton, Mass.

PIER AND BULKHEAD CONSTRUCTION IN NEW YORK HARBOR.

It has for a number of years past been the settled policy of the city government of New York, N. Y., that the water front, which is so vitally important to the city's business, shall be owned and improved by the city, and leased by it to the shipping interests requiring wharfage. The execution of this policy has been involved in many difficulties; yet the city now owns some 25 miles of the total Manhattan water front of about 40 miles, and smaller amounts in the other four boroughs of the city. This water-front property is under the exclusive control of the city's Department of Docks and Ferries, which department carries out in its entirety all improvements on the city's water front. The Department also has control over all work done on private water-front property, its approval being required for all plans and construction of such work.

With so large a field of activity, including a great variety of local conditions, in bottom varying from rock to soft mud of great depth, the New York Dock Department has developed with much thoroughness the design and construction of

FLUME WINDING THROUGH THE LOWER CANYON.

wharf structures of the kind required in New York harbor. A vast amount of highly interesting material is gathered in the designs and records of the Department, of which up to the present time only a small part has been made public. A few weeks ago Mr. Sidney W. Hoag, Assistant Engineer of the Department, presented a comprehensive survey of its organization, methods and work before the Municipal Engineers of New York, giving in particular an excellent summary of the methods developed by the Department during over thirty years past in the construction of wharfage structures. We are glad to be able to present, in the following, an abstract of this portion of the paper, which even though much condensed gives a fair review of the principal matters of interest to the engineer.

The low tidal range in New York harbor, about 4½ ft., makes closed dock basins as used in Europe unnecessary for loading and unloading vessels. Wharfage structures are therefore of a relatively simple type: piers jutting out from the shore, separated by slips capable of accommodating two vessels side by side, one lying at each of the adjoining piers. By holding the width of slips and piers down to a minimum, the maximum development of wharfage on a given length of water front is obtained. The outshore limit of the pier is fixed by the Pierhead Line, a line established by the Secretary of War, beyond which no fixed structures may be built. Inshore, the length of the pier is limited by the great value of the adjacent lands, and the consequent establishment, by the city, of a Bulkhead Line, or limit of solid fill. The length of pier thus fixed is, in general, sufficient to accommodate only a single vessel.

The required wharfage structures in New York harbor comprise, therefore, (1) Piers, and (2) Bulkheads, i. e., the seawalls retaining the solid fill of the shore. In addition there should be noted the pier sheds which extend over the piers and over a narrow strip along the shore. These sheds are, in most modern construction, double-deck structures designed for the temporary storage of freight on both floors. Their design involves many special and interesting features, due to the requirements of strength, elasticity, fire resistance, etc. However, as they are mainly a problem of steel construction, subsidiary to the design of piers and bulkheads, they are treated but briefly in the paper, and are not discussed in the abstract following:

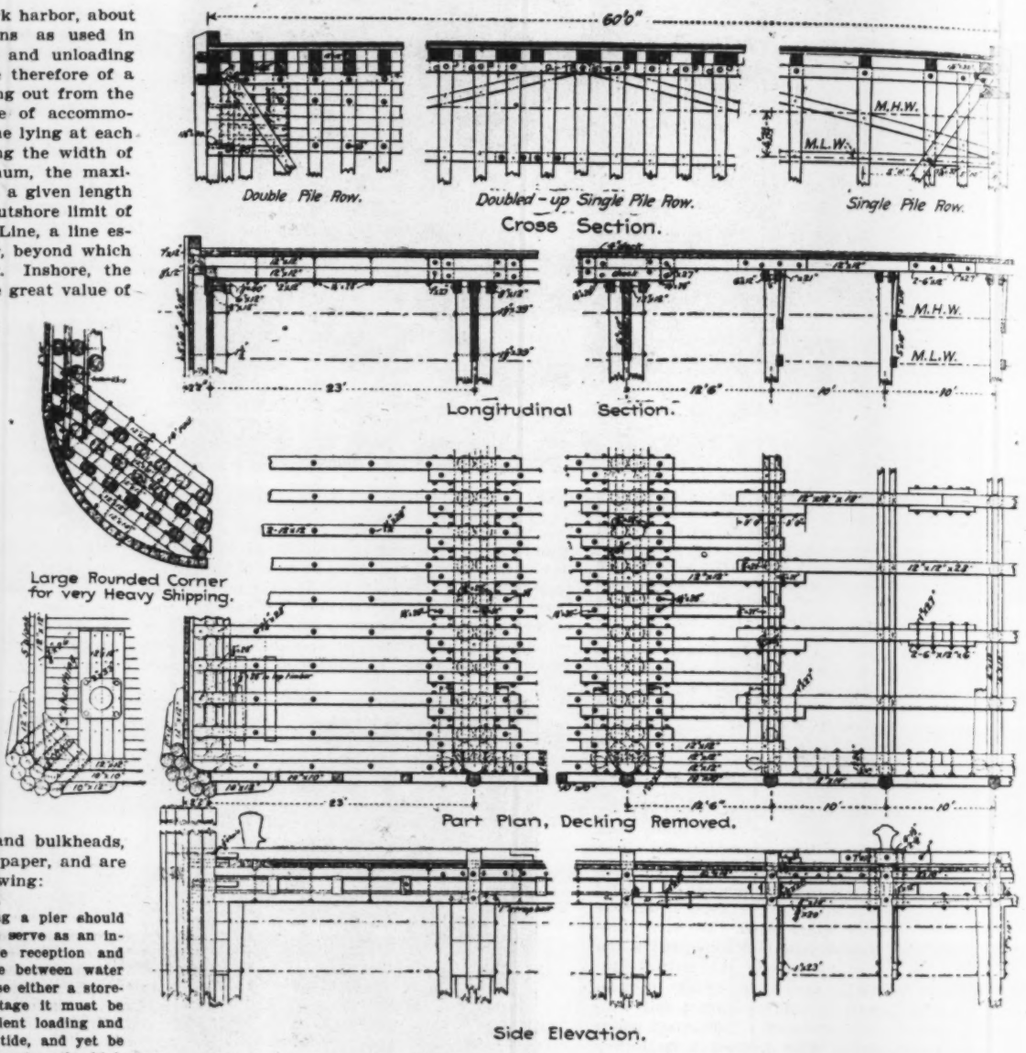


FIG. 1. DETAILS OF STANDARD PILE PIER; DEPARTMENT OF DOCKS AND FERRIES, NEW YORK, N. Y.

J. A. Bensel, Chief Engineer.

PIER CONSTRUCTION.

The predominating motive in designing a pier should be the preparation of a landing stage to serve as an intermediary in the handling and in the reception and transmission of freight and merchandise between water and land transportation. It is in no sense either a storehouse or a warehouse. As a landing stage it must be low enough to accommodate the convenient loading and unloading of a vessel at extremely low tide, and yet be high enough to avoid being awash at extremely high water. The established height of piers and bulkheads was long ago adopted in the Department at 5 ft. above mean high water, or at a grade of about + 9.25, and after an experience of thirty-five years, the Department sees no good reason for deviating from this practice. In construction, it must be elastic rather than rigid, and were it not for their perishability, the wooden piers as now constructed would be almost ideal.

When the Department began its operations at the beginning of its career, it was decided to build most of the piers of masonry or of some equally durable material; but the best commentary on this attitude is the fact that after a lapse of over thirty years but two masonry piers have ever been attempted by the Department; one of them, Pier "A," completed in 1885, was built as a foundation for the permanent headquarters of the Department and not as a pier for wharfage. The only legitimate masonry pier, therefore, on the water front is Pier No. 1, next north of Pier "A," at the foot of Battery Place. This pier, owing to its rigid construction, is about the poorest renting pier on the water front. It was begun in the fall of 1872 and completed in the fall of 1876. It consists of 18 arched spans, supported upon abutments built of concrete blocks founded upon the rock bottom, which varies from 23 to 50 ft. below mean low water. The exposed surfaces of arches and spandrels on each side of the pier are faced above mean low water with granite, with a concrete filling to asphalt grade. The pier cost more than half a million dollars, or $14 per sq. ft., about seven times the cost of a timber pier such as would be required at this locality, that is, a crib block and bridge pier, for a pile pier at this location would be impracticable. Masonry piers are, therefore, virtually prohibitive both in time and money.

The average life of a timber pier is between thirty and forty years on the North and East Rivers, and it appears that before a pier reaches its limits of durability it will more than likely have outlived or outgrown its usefulness, and will have to be replaced with a more modern structure. It, therefore, seems that timber best fulfills the requirements, all other things being equal.

At present, an 80-ft. pile driven and cut off in the work costs from $18 to $20, and in case such a pile could not furnish the frictional resistance required, the pile can be lagged so that it will drive to refusal in a mud bottom, and would cost about $23. A concrete-steel pile, supported by surface friction, would have but little more efficiency than a lagged pile, and would cost in the neighborhood of $200.

While on the subject of piles it may be interesting to note that the sewage pollution of the waters of the North and East Rivers has driven away the teredo, and there is little to fear from the ravages of this destructive form of animal life between Lawrence's Point and Governor's Island. But in localities washed by the clean, unpolluted sea water, the creosoting of piles will most likely serve as an efficient safeguard at least for a period sufficient to cover what might be called the commercial life of a pile structure.

In 1889 an examination was made of the timber columns in the outer end of Pier No. 46, North River. In the early pier construction of the Department the outer four or five rows were not built on piles, but on wh called "columns," consisting of four 10-in. by 10- low-pine sticks bolted and tree-nailed together. T was built in 1875. From the report of the div made the examination, it appears that the colum badly eaten, making it possible to encircle each four sticks with the clasped hands, the remaining being in some cases not more than 20% of the cross-section; the maximum diminution in sectio near the mud line, the loss gradually becoming to near low water. The same diver reported that *piles* in the pier were in excellent condition, fr honeycomb, and in many cases covered with bark

STANDARD PILE-PIER CONSTRUCTION.

The general principles of pier construction hav but little during the past thirty years; but the pier of the Dock Department is somewhat of an tion, differing in many details from the earlier piers. The piles are driven in transverse rows 10 ft. apart, and are spaced about 6 ft. on centers in the rows. The outer about 60 ft. of a pier comprises what is called the double-row system; the pile rows are double, with double the number of piles in each row, and are on 20-ft. centers, to provide a wider waterway for the passage of ice and a freer flow of sewage which is carried out and discharged in the double-row system from circular or elliptical conduits built in the substructure of the pier of 4-in. creosoted spruce or yellow-pine staves connecting at the bulkhead with the street sewer. With the exception of the fender system, all of the lumber in a pier is generally Southern long-leaf yellow pine of the Savannah merchantable inspection. The side bearing piles of a pier are capped with 12 by 12-in. sticks in about 30-ft. lengths, joined with 4-ft. scarfs. The transverse rows are clamped at a level 1 ft. higher than the side caps with two 6 by 12-in. sticks in the single-row system and with heavier clamping in the double-row system. Each pile row in the

single-row system is braced horizontally at mean low water with a 5 by 10-in. stick, and diagonally with bracing of the same size lumber between the horizontal brace and the clamp system. In the double-row system a center sheathing of 6 by 12-in. lumber, lying between the two piles of each pair, extends continuously across the pier from mean low water to the clamp system. The outer end of the pier is sheathed with 4 by 10-in. horizontal planking, outside of which is a 5 by 10-in. vertical sheathing extending from low water to the top of the backing log. The floor system consists usually of 4 by 12-in. planking laid transversely across the ranger system, which consists of a pair of 6 by 12-in. sticks, separated half an inch, and extending longitudinally the entire length of the pier to the double-row system in as many rows as there are piles in a row. In the double-row system the rangers are 12 by 12-in. sticks, doubled up vertically and horizontally, firmly chocked over the double rows with solid chocking between the rangers. The deck is covered with 4 by 10-in. sheathing generally laid in a narrow longitudinal strip along each side of the pier with a center strip laid diagonally. The sides and outer end of the pier are provided with a 12 by 12-in. backing log, popularly termed the string piece.

Both ends of each double row of piers are protected with armature plates of ½-in. boiler iron. The pier is further braced with an inclined pile at each end of alternate rows, excepting in the double-row system, which has two such piles at each end of each row, excepting in the outer row.

The standard fender system of a pier comprises a vertical oak pile driven at the outer end of each row, along both sides of the pier, and chocked between with horizontal and vertical chocking pieces.

The usual appurtenances of a pier comprise cast-iron cleats, single bitts and large corner mooring posts bolted to the pier structure. All parts of the pier are securely fastened with dock spikes, ranging from ½ by 10-in. to ⅞ by 28-in., and screw bolts ranging from 1 to 2 ins. in diameter, and varying in length from 12 ins. to 7 ft. All joints in timber and all bearings where one timber crosses another are liberally treated with Wilmington tar or dead oil. The heads of piles of the clamp system are treated with asphaltic cement.

The above description is very general, and takes no account of the elaborate chocking, framing of timber, fastenings and extra timbers and piles for shed foundations which enter into the construction of a substantial pier. No attempt is made at a minute or detailed description of a pier. A more intelligent idea can be obtained from the drawings grouped in Fig. 1 herewith.

The extensive piers at present under construction in the Chelsea Section (see plan in Fig. 2) are probably the highest type of pier construction yet reached by the Department, the principal variations from standard construction appearing in extra strengthening of the pile rows by means of doubled-up horizontal braces, reinforced diagonal bracing at the ends of the rows, and a heavy chocking of the end pile in each row, by means of which a lateral thrust is transmitted to the interior piles of a pier through a chocking between the pileheads. The large rounded corner (see detail in Fig. 1) is a solid construction of piles and timber, sheathed on the outside with close vertical fendering of 10 by 10-in. yellow pine, extending from about 2 ft. below mean low water to the top of the backing log, to facilitate the berthing of a large steamship, these outer corners forming a fulcrum for warping a vessel into its slip. In these piers, also, the ranger system is creosoted and doubled up horizontally throughout the entire single-row system to provide the requisite stiffness in the pier floor system to resist thrust, with a sufficient degree of elasticity to avoid injuring the concrete deck. The deck of these piers consists of 4 ins. of concrete laid on 4 by 10-in. creosoted deck planking, with a layer of metal reinforcement in the concrete to prevent possible buckling and cracking; the wearing surface is 2 ins. of asphalt. These piers are also built with foundation supports to carry double-deck freight sheds and a railroad track. They are all built to carry sewers out to discharge in deep water.

COST OF STANDARD AND OTHER FORMS OF PIERS.

There are three general classes of pier structures; the open-pile structure, just described; the crib-and-bridge type, and the solid filled-in pier, with combinations and variations of all three types. The preference for any one type must usually depend upon the controlling local conditions, such as depth of water, depth of hard or resisting bottom over the pier area, and depth of water to be maintained in the slips adjoining. All things considered, a pile pier is the best where possible, and the other types or their modifications are unavoidable departures.

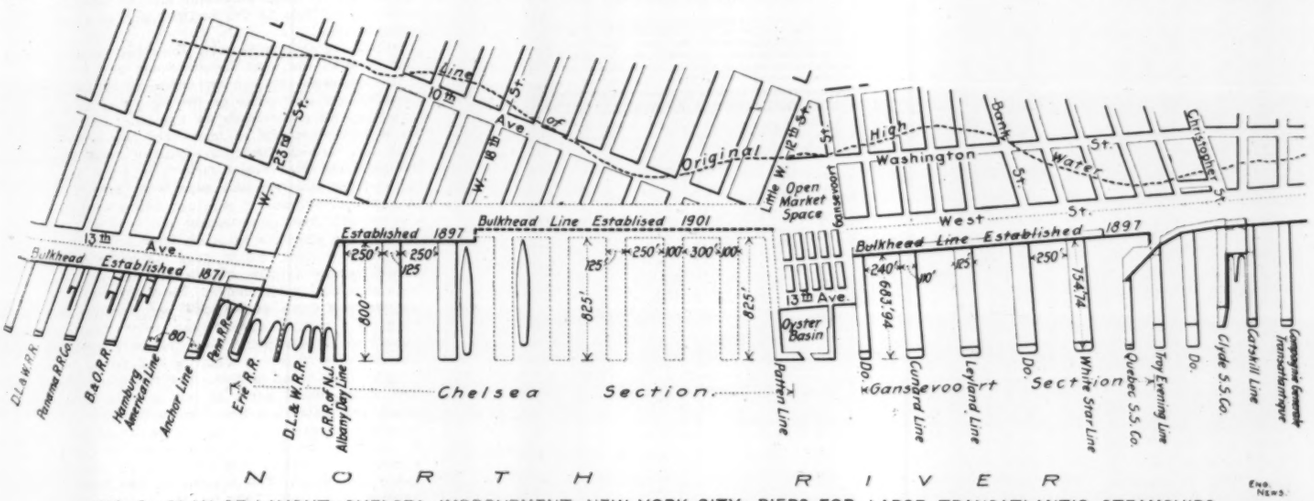


FIG. 2. PLAN OF LAYOUT, CHELSEA IMPROVEMENT, NEW YORK CITY; PIERS FOR LARGE TRANSATLANTIC STEAMSHIPS.

Piers of open-pile construction very frequently require an artificial bottom over the whole or a portion of their area, built of an embankment of riprap and usually carried to a height of about 25 ft. below mean low water. The grade of the top, however, varies according to local conditions and the character of the wharfage. As a rule, the embankment is level on top for the full width of the pier, and generally extends 5 ft. beyond the outer end of the latter, the sides and outer end of the embankment taking a natural slope of about 1½ to 1 in an open tideway. The function of these embankments is twofold. They afford a bottom penetration or medium for holding the piles where an insufficient penetration exists naturally, and they raise up to a reasonable height an otherwise inadequate bottom, reducing the leverage of the entire structure against lateral thrust and vibration. With few exceptions, this depth is not permitted to be more than 25 ft. below mean low water. Where the depth of water is such that piles, after being driven, are too unsteady or insecure, it is customary to deposit a preliminary bed of riprap 5 ft. thick and then finish the deposit of the final embankment after the driving. However, piles can be and are driven through the completed embankment, the piles being shod with cast-iron shoes doweled into the toe of the pile with a wrought-iron pin. Occasionally, questions of expedience require the completion of a pier before depositing any riprap, in which case an embankment is subsequently deposited along each side of a pier and across the outer end, extending under the pier with a top width of 10 ft. Riprap adds very materially to the cost of a pier, and its use explains the wide difference often shown in a comparison of the cost of the two otherwise exactly similar structures.

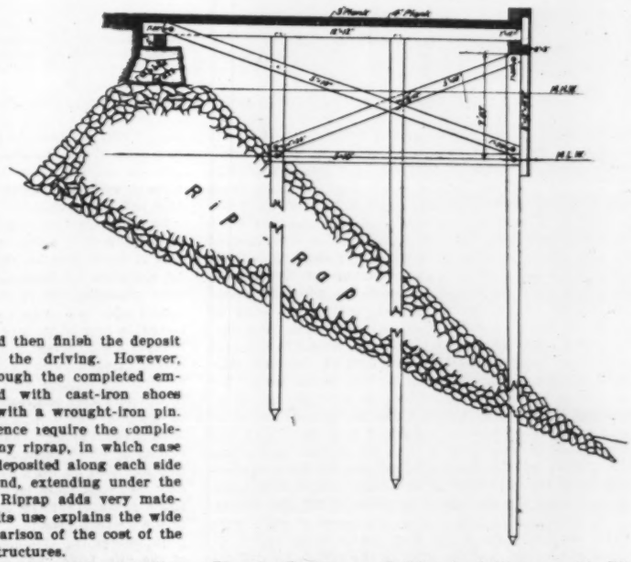


Fig. 3. Temporary Bulkhead of Riprap, with Pile Platform Screen.

The cost of a pile pier per square foot varies according to the length of piles used, and according to the relative proportion of single to double-row system, the cost of the former being about $1, and of the latter about $2.50 per sq. ft. An average pier with 60 to 70-ft. piles costs complete about $1.20 per sq. ft., without riprap or dredging. Dredging over the site of a pier is not necessary, as a rule. Riprap will add all the way from 10 cts. to $1 per sq. ft., according to the volume used, and according to the market, which varies from 45 to 65 cts. per cu. yd.

A simpler form of construction of this type, called platform construction, which resembles throughout the single-row system of a heavier pier, but in which the piles are capped flat-footed with 12 by 12-in. lumber instead of being clamped, costs at the present market price of labor and materials about 95 cts. per sq. ft., provided there are no extra piles and lumber for freight-shed foundations.

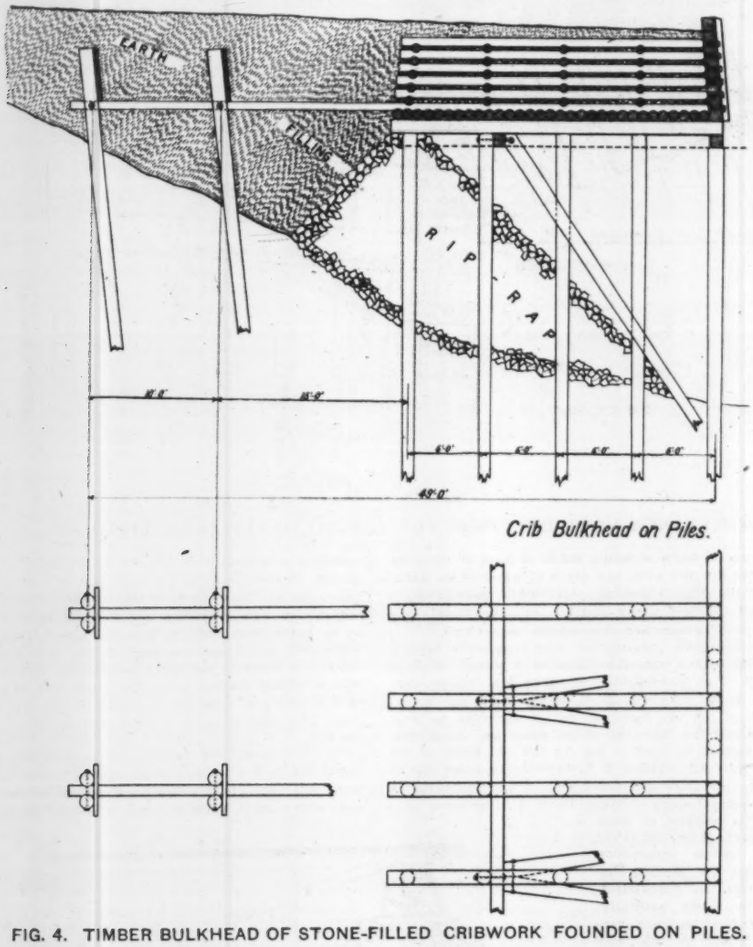
The crib-and-bridge pier is built of a series of round-log crib blocks, extending across the pier from hard bottom to mean low water, with lengths longitudinal of the latter of about 13 ft. at mean low water on 33-ft. centers, giving at the floor system an open span of about 22 ft. between adjacent blocks. The cribs are finished off above mean low water with a square timber trestle work, which serves as abutment piers for the 22-ft. spans of the deck system, carried continuously from end to end of the pier. The caps of these trestles are usually doubled up, in conjunction with provisions for wedging up and blocking up to grade from time to time, in case of any possible subsequent settlement in any of the crib blocks. The outer end block is usually a solid-built crib throughout with a square timber face. The outer end and sides of such a pier are fendered in a manner similar to a pile pier. The cost of piers of this type is about $1.50 per sq. ft.

The solid-built pier consists of nothing more than a round log rock-filled crib with square timber face above mean low water, built along the sides and across the outer end, with a solid filling of earth or ashes behind the cribs to grade. The cost of such a pier depends almost solely upon the dredging and cribwork, as the filling costs nothing, as a rule. Dredging for the cribs should be carried to hard bottom and below the depth required in the slip. It would be misleading to attempt to estimate the cost

per square foot; for a pier 200 ft. wide would cost only so much more than a pier half its width as the extra 100 ft. of cribwork would cost. In other words, the cost is, in this case, a function of the wharfage room and, depending upon the depth of the dredging, will average about $42 per lin. ft.

SAFE LOADS ON PILES.—Pier piles are required to be sound and straight white pine, yellow pine, Norway pine or cypress, with at least 6-in. points, and butts to cut off usually not less than 16 ins. in the double-row and 15 ins. in the single-row system. They are driven usually until they refuse to penetrate more than 1 in. per blow under the last 10 blows of a 3,000-lb. hammer, falling 10 ft. The pier piles are distributed to carry a safe load of 15 tons per pile. Extra piles for freight-shed foundations are distributed to carry from 12 to 15 tons per pile, depending upon the nature of the bottom. In the piers in the Gansevoort Section, most of which have double-deck freight sheds, the foundations were designed to carry 12 tons per pile, the bottom being over 100 ft. of mud. The piles were 80 ft. long and drove 6 ins. under the last blow of the hammer. According to the Engineering News formula, these piles are only good for a safe load of 4¼ tons. None of these piers have shown any appreciable settlement since they were put in commission seven years ago. The more experience a person has with the actual behavior of piles under heavy loads the further away he is apt to stray from any set or established formulas. Seventeen years ago, the action of an extraordinary load on the pier near the foot of West 26th St. received some study, when an area 20 by 50 ft. was loaded with 1,200 lbs. per sq. ft., and another area 10 ft. wide and 75 ft. long was loaded with nearly 1,300 lbs. per sq. ft.; after making all allowance for weight of pile, dead load and distribution of live load, it was found that the actual load carried by the piles involved was in the neighborhood of 35 tons, developing an actual surface resistance, obtained from the average of 14 piles, of 767 lbs. per sq. ft. (a minimum of 700 and a maximum of 839), with about 40 ft. of pile in the mud. Some years ago T. C. Clarke announced that the piles in the foundations of the Hawkesbury Bridge developed a surface frictional resistance of about 500 lbs. per sq. ft. It is the writer's firm conviction that piles driven in a soft bottom may be loaded to a point that will often rupture the bottom before starting the pile.

It may sometimes happen that the bottom may be of such a nature that it would not be safe to stop driving when the limit for an 80-ft. pile is reached. If the indications are that rock or other hard, resisting bottom can be reached with a pile spliced to 100 ft. or so, then splicing is likely to be more effective and cheaper than lagging. The splice at present used by the Dock Department consists of six pieces of 5 by 5-in. spruce or yellow pine, each 14 ft. long, used as three pairs of fish-plates, the two ends of the pile being dressed at the butt joint to a hexagon with 5-in. faces. Opposite fish-plates are fastened together with three ¾-in. screw bolts on each side of the joint, with three ½ by 9-in. dock spikes in each fish-plate on both sides of the joint. The two ends are also doweled together with a 2-in. white-oak dowel 12 ins. long. The average pile tapers in diameter about 1 in. in 7 ft., therefore requiring for a pile spliced to 110 ft. one 60-ft. and one 80-ft. pile, the lower section to cut off not less than 14 ins. at the joint with a point not less than 6 ins., making the upper section a 17-in. butt cut off not less than 10 ins. in diameter at the joint. Thus it will be observed that splicing is apt to be expensive and wasteful.



Crib Bulkhead on Piles.

FIG. 4. TIMBER BULKHEAD OF STONE-FILLED CRIBWORK FOUNDED ON PILES.

To overcome this, the Department has recently resorted to a device used elsewhere for increasing the surface friction of an 80-ft. pile, and therefore its supporting power, by a system of lagging. If the conditions indicate that piles exceeding 80 ft. in length are required, they are lagged with two or four streaks of 5 by 6-in. spruce, each streak in two 15-ft. lengths, fastened to the pile in pairs with two 1-in. screw bolts and with two ⅝ by 12-in. dock spikes in each piece on the lower portion of the pile, extending upwards to within 45 ft. of the sawed-off butt to insure full mud immersion. The efficiency of this method of lagging was determined from a set of experimental tests made by the Department about two years ago, the results of which seem to show that in a deep mud formation like that on the Chelsea Section, piles thus reinforced may be relied upon to safely support 20 tons. Time and space prevent a more detailed discussion of this subject at the present time.

Up to 100 ft., splicing will add about $17 to the cost of the pile driven and stay-lathed; and lagging (piles 80 ft. long) will add about $12 to its cost, driven and stay-lathed.

BULKHEAD CONSTRUCTION.

TIMBER BULKHEADS.—The bulkhead is the retaining structure which forms the limitation of solid filling, and may be temporary or permanent. Temporary bulkheads may be economically built of riprap, sheet piling or cribwork; the permanent bulkhead or seawall is some form of masonry.

If of riprap, it usually consists of an embankment carried up to about half tide, topped off with a light stone wall with a timber platform (on piles) of required width in front, the piles being driven through the riprap slope. (See Fig. 3.)

Where a good penetration is possible there are several kinds of sheet-pile bulkheads well adapted for economically retaining shallow filling, consisting of a row of piles, capped and waled on the inshore side with yellow pine at mean low water, at mean high water or at the top, for the support of the vertical planking. This type of bulkhead may be braced in front by inclined piles where wharfage is no object, or may be tied back in the rear to a set of anchor piles. The ground in the rear of these bulkheads may be planked, or paved. They cost in the neighborhood of about $ per running foot.

Of all the structures with which the Department has had to deal, the most uncertain and unsatisfactory are crib bulkheads. No one can afford to predict their behavior; they may bulge on the face; they may maintain a constant profile but bulge for line; they may show an inshore movement at times; they may settle or they may not. Crib bulkheads are built of round logs longitudinally and transversely, forming cells 8 ft. long lengthwise of the structure and about 5 ft. wide transversely. A sufficient number of cells are floored over just above the probable limit of settlement and filled with riprap for sinking the structure to place, after which all the cells are likewise filled. Above mean low water the wharfage face is usually finished off with square 10 or 12-in. yellow pine with half-round fenders. No longitudinal log should be less than 6 ins. at the small end, nor less than 20 ft. long, as a rule. Transverse logs below mean low water should not be less than 8 ins., and above mean low water not less than 10 ins. in diameter, and should be in single lengths from front to rear. The fastenings below mean low water should never be less than ¾-in., and above mean low water not less than ⅞-in. dock spikes. For wharfage purposes, the front profile should have a batter of about 1¾ ins. in 12. The back may be vertical or inclined, with a step of from 6 to 12 ft. or more in width at mean low water. The Department has built up to the present time about 17,550 lin. ft. of crib bulkhead.

The usual crib construction requires a top width of not less than 16 ft. for a depth not exceeding 10 ft. below mean low water and from 18 to 25 ft. and upwards, increasing at mean low water to 30 or 40 ft., if necessary for greater depths. The bottom width or distance between centers of front and rear longitudinal logs should never be less than the over-all height in order to secure the necessary weight for stability. For great depths, say, from 30 to 40 ft., a crib will require a reinforcement in the nature of anchor cribs in the rear, which are in effect a widening of the crib transversely below mean low water. A crib bulkhead should never be founded upon any other than hard bottom, all soft material being removed by dredging. In almost any bottom other than rock or hardpan a crib will settle more or less, but where a level bottom of hard material can be obtained there is no reason why, with ordinary care in filling in behind, a crib of this character should not hold its position and line fairly well. But the dredging does not always leave a level bottom or a bottom of uniform consistency, and before the filling in the rear has progressed very far, which should always be deposited from the crib inshore to drive any possible mud wave away from the structure, it is apt to show signs of movement. In the case of a very hard or rock bottom the bottom logs of the crib must be laid out to fit the surface upon which it is to rest as developed by contours. An extreme case of this kind was built about four years ago at the foot of East 80th St. The rock sloped outshore in several places more than 30° and was very irregular longitudinally, necessitating the laying out of almost every course of logs up to mean low water. The logs were cut to lengths indicated on diagrams furnished the contractor, the crib was built accordingly, floated into position, anchored, loaded and sunk, and as described by the engineer in charge of the work, it "took its position like melted cheese." The reason why this crib has not budged is probably because it was anchored to 2¼-in. pins bedded into the rock in the rear with 1¼-in. chain.

A departure from the solid construction is often met with where cribs are supported upon piles. (Fig. 4, the inclined piles omitted.) This type is no longer used in the Department and is not to be recommended. The excuse for its existence is the saving in dredging. Piles are arranged in rows on 6-ft. centers between rows, cut off at mean low water, capped, close floored with round logs, and the structure finished up to grade with cribwork; alternate transverse rows of piles are braced with an inclined pile. The rear row of piles lies in the center of a riprap embankment and retains the filling.

The writer believes that this form of bulkhead may be made efficient by the use of two bracing piles, either in tandem or in pairs, and by tying the structure back with some of the bottom cross logs to properly sheathed anchor piles, as shown in Fig. 4.

MASONRY BULKHEADS.—Generally speaking, four types of masonry bulkhead or seawall in the Department, de-

pended upon the character of bottom encountered as determined by borings and test piles, with modifications suggested by experience or by unusual local conditions. These types may be enumerated as (1) the shallow-rock section, (2) the deeper-rock section, (3) the hard or firm bottom section, and (4) the soft bottom or deep mud section.

Before describing the different types of wall, it may be well to point out the features in the construction com-

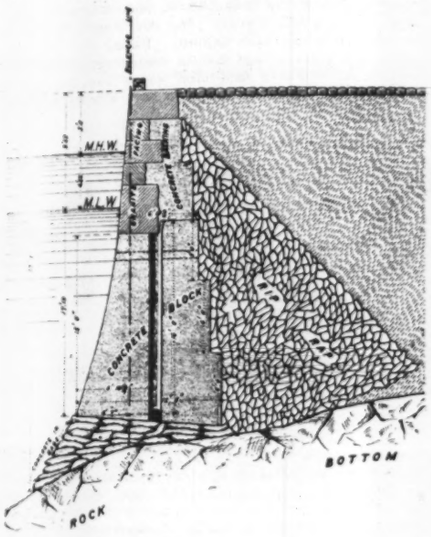


Fig. 5. Typical Construction, West 52d St., South End.

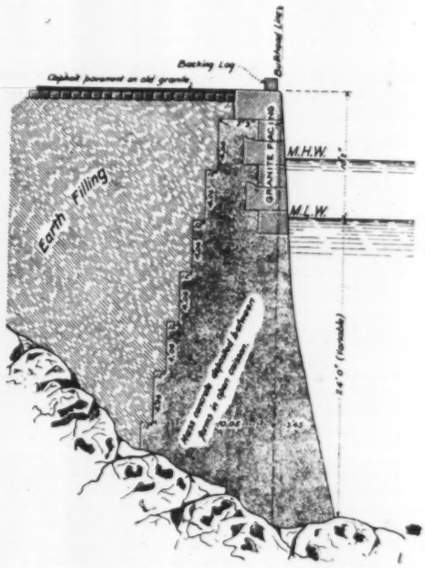


Fig. 6. Mass-Concrete Base Wall, East 116th St.

FIGS. 5 AND 6. SHALLOW-ROCK SECTIONS OF BULKHEAD WALL, NEW YORK DOCK DEPARTMENT.

mon to all types. With few exceptions the upper portion of a wall rests upon a heavy concrete block with a front parapet about 2.45 ft. below mean low water made to receive the bottom course of the granite facing, which extends from this elevation with a front batter of 1 in 12 up to the surface grade (+ 9.38, as a rule). The granite facing is in four courses surmounted with a coping. Each course is laid with alternate headers and stretchers, the headers being cut dovetailed in the back to bond in with the mass concrete backing which extends from the top of the concrete block to the under side of the coping and back from the face from 5 to 8 ft. The face and back of the granite are quarry-faced, with ends and beds pointed off, the tops being 5-cut, hammer-dressed for a width of 3 ins. from the face. The ends of all stones are cut dovetailed with a slope of 1 in 12; the coping is pean hammered on top with ends and bottom cut smooth for a width of 5 ins. A 12 by 12-in. backing log is fastened to the coping with expansion bolts. The backing log may or may not be provided with cleats.

An embankment of riprap is deposited in the rear, carried up to high water or to nearly the coping grade, with a top width of 5 or 6 ft. An embankment of riprap is also usually deposited in front of the wall, the slope of which intersects the face of the latter at about — 13.

The concrete blocks are all molded in air at one of the two Department yards and allowed to stand from 10 to 14 days before shipping to the work. The concrete is a 1:2:5 mixture; the mold boxes are cored for chain grooves and chain holes. In the work these grooves match in adjacent blocks and are packed with concrete in bags. Although the blocks vary in size and weight, the tops of the main base blocks are very similar. The portion in the rear of the parapet is molded in such a way as to form with adjacent blocks a series of salient and depressed dovetails with which the concrete backing forms a complete bond. These blocks vary in weight from 35 to 80 tons. There is a great lack of uniformity in the weights of sub-blocks, ranging as they do from 34 to 95 tons, and from 6 to 18 ft. in length on the face.

1.—Shallow Rock Section.—Where rock is found at a depth of about 25 ft. or less the wall area is dredged off thoroughly, and with the aid of a diver the rock surface, holes and pockets are pumped off clean with an 8-in. pump capable of passing bricks and small stones. The foundation is then prepared by laying up concrete in bags about 3 ft. long, 2 ft. wide and 8 ins. thick to a foundation level, having an inshore slope of 1 in 12, dressed off with a gravel concrete mortar by the aid of divers and heavy iron straight edges, worked back and forth, to receive the base blocks. These blocks are usually about 17 ft. high, 6 ft. long on the face, with a base of about 12½ ft., a top width of 7 ft. and stepped off in the back. They weigh about 70 tons.

Fig. 5 shows the wall as built at the West 52d St. Section, south end. A modification shown in Fig. 8, at the East 116th St. Section, has a mass concrete wall built in an open caisson or cofferdam on rock 25 ft. below mean low water. This is the only instance in the Department of this kind of construction. The wall has a bottom width of 15 ft.

Of the shallow-rock type about 1,125 ft. have been built.

2.—Deeper-Rock Section.—For depths of from 25 to 40 ft. to rock, covered with soft material, the latter is dredged and the foundation prepared in the same manner as before described; the wall differing mainly in having one or two sub-blocks from 5 to 9 ft. high, according to depth. The top block is 19 ft. high at the back, with a bottom thickness of 14½ ft., and a top thickness of 8 ft.

The principal modifications of this type are on the Broad St. Section, with a rabbeted joint between sub and base blocks, and on the East 74th St. Section (see Fig. 7), where the rock is unusually steep and shelving requiring special sub-blocks every few feet, the cavities in the rear between these sub-blocks and the rock being filled with mass concrete as the blocks are set. The Cedar St. Section, shown in Fig. 14, is the most recent modification of this type, and is now under construction. Rock is about 40 ft. below mean low water. In this wall the bottom course comprises a front and rear sub-block 18 ft. long on the face, with broken stone filling between. The two upper blocks are 6 ft. long. The bottom blocks are 93 and 88 tons, respectively.

In 1871 General McClellan began operations at the Battery and built the Battery Section. The rock at about —46 was dredged off to firm bottom. A riprap embankment was deposited with a top width of about 26 ft., topped off at —20 with a bed of concrete and broken stone 2 ft. thick. From this grade the wall was continued up in fifteen 2-ft. courses of granite with a bottom width or base of 19½ ft. The following year he carried up his embankment to —14, and began the system of concrete-block construction, substituting for the granite two courses of concrete blocks.

Up to the present time the Department has built about 2,643 ft. of the deep-rock type of wall.

3.—Firm-Bottom Section.—When the bottom is of such a nature that piles will drive to refusal or to rock and be embedded in firm material for most of their length, requiring but little more dredging for the removal of any soft material than is necessary for cutting off foundation piles at the proper depth, this section is used. The type is adapted for depths of from 50 ft. and upwards to rock, in a bottom sufficiently firm or compact to prevent any forward movement of the piles either from the vertical or in mass. Dredging is carried to a depth of about 20 ft. The piles are cut off at about —15, and their location checked by a diver with the aid of a heavy wire screen. Extra piles are driven wherever the screen indicates insufficient bearing, for with the utmost care piles when cut off at this or greater depths will sometimes fall outside of the bearing area required. Fig. 8 shows the pile locations in a certain portion of wall determined in this way after cutting off. The dotted circles indicate the extra piles which were required, the others having been intended to form regular rows. The loose or soft mud between the piles and for about 20 ft. in front is pumped or washed down to hard material, and the space above filled up with cobble to the tops of the piles, or to the cut-off grade. Mattresses of mortar mixed 2½ to 3 are placed on top of the piles to insure a firm bearing for the base blocks, which are 6 ft. long on the face, 17 ft. high at the back, 10 ft. wide on top, 15 ft. wide on the base and weigh 77 tons. Riprap is deposited in front and rear. This type was first used on the East 102d St. Section in 1891, these blocks being the first molded with the dovetailed tops.

A modification of this type appears in the East 23d St. Section. Two sub-base blocks, with a rabbeted joint between, are used, making together a top width of 7 ft., a bottom width of 10½ ft., a total height of 16½ ft. and a face length of 8 ft. The bottom and the top blocks weigh respectively 34 and 38 tons. In the wake of the ferry structures on this section, where the exposed face is concealed, the top of the wall is formed of a third block. The two lower blocks were designed for an entirely different type of wall to permit handling by the 40-ton derrick at a time when the 100-ton derrick was undergoing repairs. They were made available in this type, however, by the use of a relieving bed of concrete deposited in the rear around the heads of three longitudinal rows of piles for a width of about 10 ft., and carried up with a slope to the back of the blocks about 9 ft. above the tops of the piles.

Of the firm or hard-bottom type about 3,784 ft. of wall have been built.

4.—Soft Bottom or Deep-Mud Section.—The extreme condition that prevails in this type of wall is a mud bottom, increasing in density with depth, overlying rock at a depth of about 170 ft. below mean low water, as on the West 23d St. Section, south end. The minimum depth of rock for this type is about 40 ft., as on the East 91st, the Dey St. and the West 57th St. Sections. The Department construction thus far has involved all kinds of depths of mud between these two.

In 1873, General Graham began the construction of the Christopher St. Section, using the method shown in Fig. 9, without the riprap in front and the relieving piles in the rear. This wall showed evidences of weakness after several hundred feet were completed and filling in the rear was begun, but the outward movement was checked by depositing a heavy embankment of riprap in front of the wall (as shown in the drawing). The principal feature of this wall was a bed of concrete about 2 ft. thick at the tops of the piles, which it was supposed would stiffen the foundation materially in a horizontal direction; but the mass was not only broken up by the large number of piles, but the concrete itself was badly washed out, leaving practically a 2-ft. thickness of small stone filling where a strong mass of concrete was expected. The relieving piles in the rear were driven, subsequently, at the recommendation of a Board of Consulting Engineers.

The Morton St. Section, Fig. 10, is a later modification of General Graham's wall made by his successor, George S. Greene, Jr, in 1875, consisting principally in the introduction of a grillage braced underneath with inclined piles. The grillage consisted of two courses of 4-in. spruce plank, laid at right angles with each other, fas-

Fig. 7. Deep-Rock Section of Bulkhead Wall, New York Dock Department; Special Base Detail on Steep Sloping Rock, East 74th St.

tened together with ⅞-in. treenails, and fastened to each pile with a 3-in. oak treenail driven 12 ins. into the top of the pile.

The construction designed by General Graham for a later portion of the Canal St. Section, to which he pinned his faith with enthusiasm, was intended to be the prevailing construction for deep, soft bottom. Piles were punched down to an average distance of about 13 ft. below mean low water with a heavy oak follower 12 ins. square and 26 ft. long, armed at the bottom with an iron thimble and banded with iron to strengthen against frac-

ture. This uneven punching was intended to provide a good grasp to the concrete around the pile heads. From the tops of the piles up, the construction is a mass concrete wall with granite facing above mean low water. The concrete was deposited in uncovered buckets in a wet caisson. General Graham resigned in 1875, and shortly afterwards the Commissioners received from outside sources adverse criticisms of that portion of the wall built under this type. The Board, therefore, ordered George S. Greene, Jr., General Graham's successor, to make an examination of the wall and report its condition. An examination of the face of the wall was accordingly made, chiefly with the aid of divers.

The latter reported the lower portion of the mass concrete construction to have fallen away at the toe entirely exposing the front row of piles, with very little bearing upon the second row. The bottom of the mass was found to consist chiefly of the broken stone portion of the concrete, the cement having been washed away in the operation of depositing the concrete. In the report of the Engineer-in-Chief, he protested against the further continuance of this form of construction until after the advisability of proceeding might be determined by a board of expert engineers. Consequently, at the solicitation of the Commissioners, the Mayor appointed General Newton, General Gilmore and Wm. E. Worthen a Commission to examine into this subject and report their findings with recommendations. The investigations of this Commission were of an exhaustive nature, combining a series of examinations along the entire face of the wall with the aid of two sets of divers, one set being used as a check upon the other, an examination made by sinking shafts through the interior of the mass down to the pileheads, and experimental observations wherein a large box was constructed with pile butts arranged on the bottom in the same manner as in the wall, the box being sunk and filled with concrete and deposited in the same manner as was done in building the wall. The result of these investigations confirmed those made by the Engineer-in-Chief, and showed large cavities existing around the pileheads in places, and the bottom of the mass consisted chiefly of the loose broken stone of the concrete covered with "laitance" in places, which, when taken out and thrown into the water, floated away. The experimental box, when raised from the water where it had been immersed for several weeks, showed that beyond question the defects reported by the divers actually existed in the work.

The Board reported against the continuance of this method of construction and recommended the building of a platform in the rear of the wall of sufficient width to take the entire weight of the back filling and surcharge to relieve the wall from thrust and possible destruction; for it must be borne in mind that at the theoretical point of rotation there was no fulcrum or toe that could be relied upon. Quoting from the concluding remarks in their report, they say:

We cannot condemn a *system* of which many successful examples are reported, with which we are conversant, nor under certain circumstances and necessities should we hesitate to adopt it; but these do not obtain in the construction of these bulkheads; and we should recommend that all exterior faces here should be constructed in blocks and deposited on the pile foundations.

This led the Engineer-in-Chief to design an entirely new section, which is shown in Fig. 11. The fundamental principle of this type of wall is the impossibility of overturning an embankment of riprap. It may settle or it may move outshore, but it cannot overturn. It will be noticed that virtually we have an embankment of riprap with a hearting of piles to carry a wharfage face of concrete blocks and granite. The most important feature of this wall is the relieving platform in the rear, braced with inclined piles to take the thrust from the rear filling and surcharge entirely away from the wall proper, and transmit it vertically to the mud or other bottom. By this device the concrete block which forms part of the wharfage face may be made very narrow fore and aft, as the only thrust on this portion of the wall is that which is transmitted by the riprap filling *under* the relieving platform, and this thrust, owing to the frequency of piles in the relieving platform can never amount to the thrust from an embankment of the same dimensions not broken up by these piles. Thus, the saving in concrete with its attendant expense in the labor of placing it is very considerable. The concrete block used in this type is 7 ft. thick on the base and 12 ft. long longitudinally, weighing in the neighborhood of 70 tons. Less than three rows of piles would not be permissible for stable construction, and the block is as narrow as this requirement will permit. But even so, in order to avoid the danger of any of these piles, especially those in the front row, from working out from under the blocks, a binding frame, shown in the drawing, is introduced. This will hold these foundation piles in position relatively with the relieving platform piles, and becomes a very important and indispensable feature of this type of wall. These frames are wedged against the outer piles, front and rear, by a diver. The essential details in the construction of this wall are clearly shown in the plate.

At intervals of from 35 to 75 ft. a vertical joint is provided, extending from the tops of the foundation piles between binding frames up through the coping, the object of these vertical joints being to enable a section of the wall to settle without serious damage to the adjacent blocks or to the granite facing, and this is exactly what has happened. Periodical examinations of the wall as it progressed during its construction were made to determine and alinement, and the oldest portion of this wall, which is in the vicinity of the West 24th St. pier, a settlement of about 3.6 ft. in fifteen years. The rate of settlement has not, by any means, been uniform. During the first and a half years it was 2.4 ft.; during the next two years it was 0.6 of a foot, after which time, for ten years, the settlement seems to have become

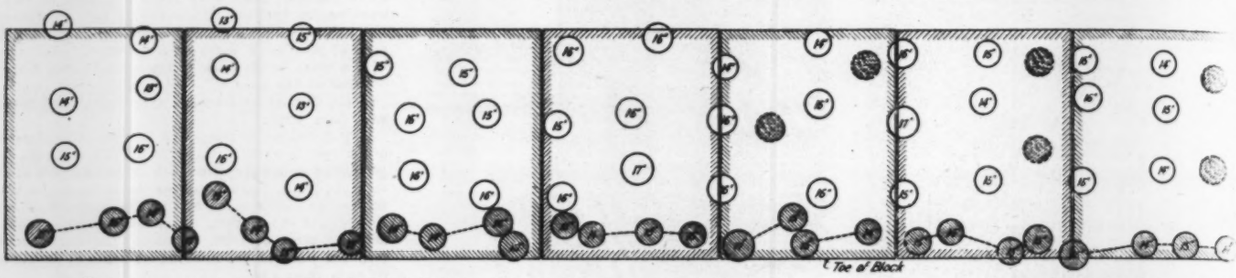

Toe of Block
Foundation piles in front row shown thus
Remaining foundation piles shown thus
Extra foundation piles at ends shown thus

FIG. 8. SAMPLE OF PILE LOCATIONS AS DETERMINED BY "SCREENING," IN BULKHEAD FOUNDATION WORK; NEW YORK DOCK DEPARTMENT.

and at the rate of about ¾ of an inch per year. That portion of the wall most recently built between West 23d and West 24th Sts. shows a maximum settlement of about 3.45 ft. during the period of observation extending from November, 1893, to June, 1895, nineteen months; this settlement being uniform throughout this period, and had become about 4 ft. when the last levels were taken three or four years ago. This seems to show that the mud bottom underlying the wall foundation compresses rapidly, owing to the weight of the wall and the filling in the rear, and then gradually becomes sufficiently compacted to support the wall and the filling without much further settlement.

This type of wall seems to be unquestionably adapted to mud flotation. The effect of excessive settlement has been overcome, so far as the granite facing is concerned, by omitting or removing the coping, which was laid temporarily, and adding courses of granite from time to time to bring the wall up to grade, one or two extra courses being required at different locations; and it has been found that immediately after the addition of extra granite with its backing of concrete the rate of settlement was increased during the first year or two.

This settlement of the bulkhead wall on the deep-mud sections is accompanied with a corresponding settlement of the entire mass of mud in its immediate vicinity, extending in the neighborhood of 100 ft. outshore of the wall.

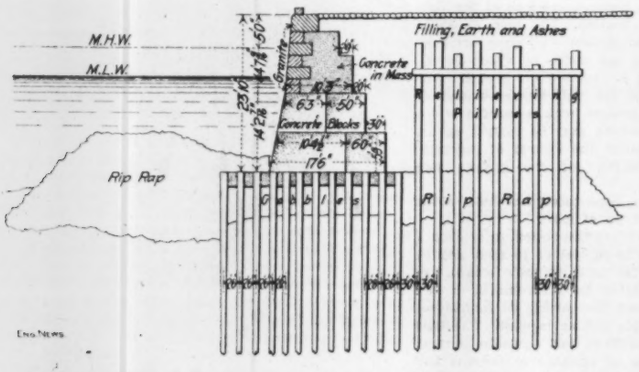


Fig. 9. (1873.) Design for Bulkhead near Christopher St., North River, Modified by Riprap Toe and Grid of Relieving Piles in Back-filling.

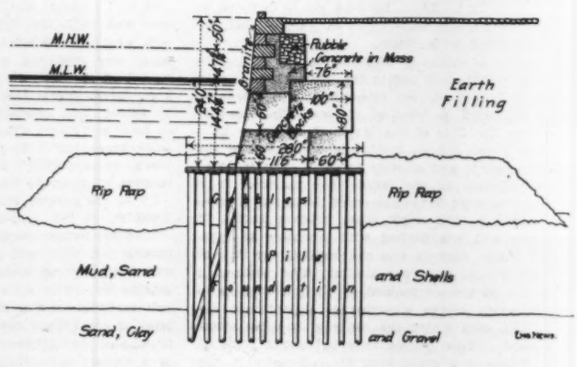


Fig. 10. (1875.) Design for Bulkhead near Morton St., North River.

FIGS. 9 AND 10. EARLY BULKHEAD CONSTRUCTION IN SOFT BOTTOM, NEW YORK HARBOR.

The behavior of this wall has been remarkable. It has been built along those portions of the North River waterfront where the mud formation is deepest, and where it was impossible for unspliced piles to bring up in driving. No spliced piles have ever been used in the bulkhead wall construction. The rock bottom in the deepest section of this type of wall is in the neighborhood of 170 ft. below mean low water, namely, in the vicinity of West 23d St. As was anticipated, the settlement on this section has been very considerable. The construction of the wall as far north as West 33d St. extended over a period of fifteen years and was built in lengths of several hundred feet at a time, the question of property rights restraining the Department from making a continuous piece of work.

and carries down with it the inshore ends of the piers which spring from the wall in this locality. The effect on the piers is overcome by a system of double capping, separated with temporary chocks, which permit the blocking or wedging up of the superstructure from time to time upon the lower cross cap.

The deviation of the wall from its original alinement reaches a maximum of about 0.5 of a foot between West 23d and West 24th Sts., covering a period of about eight months. In places there has been an *inshore* movement of the wall of about 0.2 ft.

As confirming the theory of mud flotation, it may be stated that examinations made of the batter of the wall show practically no changes.

In 1895 a Board of Consulting Engineers, consisting of General Lincoln Casey, George S. Morison and Wm. H. Burr, was appointed by the Mayor at the request of the Commissioners of Docks to report upon the methods followed in Dock Department construction, with a view to making recommendations for improving the wharfage facilities, etc., of New York City. Their comments on this type of wall may be of interest. The following is quoted from their report, dated February 6, 1896:

"To float a wall in mud when that wall must also take a horizontal thrust is a problem which can only be solved with care and experience, no formulas or mathematical rules being available. The wall, as now built, is a satisfactory solution of the problem. Your Board believes it to be a unique construction, one which is worthy of the most careful study, and deserves the strongest commendation. Its development has been gradual, and it is probable that future improvements will be made; but this Board does not hesitate to say that it considers this wall a solution of a very difficult problem, which is remarkable for its originality and the excellence of its results.

Up to 1898 the only modification made in this type of wall was the raising of the relieving platform 1 ft., in order to expedite the work and increase the speed of low water work.

After consolidation in 1899, the present Engineer-in-Chief, Mr. J. A. Bensel, M. Am. Soc. C. E., made the first important modifications in this type of wall. The binding frame had always been a troublesome and expensive feature, and to meet Mr. Bensel's efforts to cheapen the construction of the wall without impairing its efficiency one of the longitudinal rows of platform piles was incorporated in the foundation, making four rows instead of three. The concrete blocks were redesigned with a base of 10½ ft. instead of 7 ft., and the binding frame was abandoned. At this time the 100-ton floating derrick, which had been doing continuous service for nearly thirty years, required overhauling and repairing. So, in order to avoid any delay in the setting of base blocks, the Department built a 40-ton derrick, and the blocks were designed of such a weight as might be handled with the new derrick. Thus, the wall, as modified by Mr. Bensel, and called the "modified wall of 1899," Fig. 12, shows two blocks with a rabbeted or offset horizontal joint between, the lower one weighing 34 tons and the upper one 38 tons. These blocks are, however, molded as one for handling with the 100-ton derrick. Another important modification consisted in reducing all of the granite about one-third in fore and aft dimensions, the granite serving as an ashlar to the concrete backing, which must be particularly heavy to resist the impact of vessels wharfing or mooring. The platform is 1 ft. higher than in the foregoing type or "wall of 1876," making it possible to prosecute the work with longer tidal intervals and with fewer delays from the infrequency of low water, which sometimes happens with exasperating monotony, and during which period, of course, no work could be done on the relieving platform (at the old grade).

This wall has been called upon to respond to demands upon it of a nature not anticipated in the earlier types. For instance, along South St., where the dredging for the wall has encroached upon what might be called the prism of influence underlying the old crib bulkheads along this section, the danger of sudden movements in the latter has been a source of more or less anxiety, until the expedient of tying the wall back to special anchor piles was adopted. This tie consists of a 12 × 12-in. yellow pine stick notched down over the longitudinal key in the platform and extended back and framed in between a pair of braced anchor piles securely waled top and bottom, the waling being framed into the tie, the latter being extended several feet to provide ample resistance against shear with the fiber. This tie is positive, for the concrete backing in the rear of the granite facing and overlying the platform, bonds in with the longitudinal key in the latter, and transmits tension through the mass concrete backing to the concrete block itself. The frequency of these ties or the distance between centers depends as much upon judgment as upon anything else, for the dynamic effect of any movement (actual or anticipated) against which this expedient is introduced is utterly indeterminate.

Again, on the Chelsea section, where the entire region is made land or filled-in land extending about 1,000 ft. in the rear of the bulkhead line, it was expected that in dredging the area in front of the wall to 40 ft. for the accommodation of the deep draft vessels that are expected to occupy this waterfront, the removal of this prism of compacted filling might exert an influence upon the prism of the same kind of material in the rear released from this support and cause sudden movement of the latter. In carrying out the improvement on this section, rapidity of construction was made a dominant feature, and the "wall of 1899" was accordingly modified to meet the unusual physical conditions combined with speed in operations. The base block is a monolith 12 ft. long, 9½ ft. on the base, 15 ft. high and weighs 96 tons. It is supported upon a mattress, resting upon fifteen piles, driven in four rows, six in the front and three in each of the others, driven staggered, providing extra resistance at the heel against the opening of the joint at the toe between block and foundation piles. The latter are driven through an embankment of cobble deposited over the dredged area, with a depth of about 13 ft. The usual riprap embankment is deposited in front and rear. The pressure from surcharge and filling is transferred to the pile portion of the structure below the dredging line by a relieving platform 26 ft. wide, built as a grillage of three courses of 4-in. plank laid close, the middle course diagonal, supported upon three transverse rows of four piles each in the rear of every block. The grillage platform is braced with two inclined piles in every alternate row, driven in tandem, and is tied directly to the blocks by 2-in. tree-nailed fastenings to 12 × 12-in. yellow pine spuds supported upon the rear step and fastened to the backs of the blocks on 3-ft. centers with expansion bolts, in addition to the usual tie made by bonding the concrete backing on to the platform through the agency of a heavy 12 × 12-in. longitudinal key. It is expected that this wall will be cheaper and more rapid to build, and still afford the requisite resistance to unusual distortion from any movement in the old filling in the rear of the excavated area.

Another modification of this type of wall (soft bottom or deep-mud type) occurs at the West 42d St. section, where the piles bring up on rock at about —50 ft. with mud overlying it. The bottom was dredged to —35 ft. The foundation piles were cut off at —19. The wall proper is heavier, with a pile foundation of five rows, instead of four. The combined height of the concrete blocks is nearly 20 ft., with a bottom width of 13 ft. 3 ins., and a top width of 7 ft. The riprap embankment in the rear is heavier and broader; the riprap in front is reinforced with a heavy embankment of derrick stone, and thus the inertia and stiffness of the entire wall has been increased against the possible outward movement of the underlying mud from the pressure of the filling in the rear.

The most recent modification of this type of wall is at the Rector St. section, Fig. 13, where we return to the single block 10½ ft. on the base, supported upon three rows of piles. The relieving platform is replaced with a mass concrete reinforcement in the rear of the base block to which it is locked by a dovetailed joint. Bracing piles in pairs take any thrust transmitted from the concrete reinforcement, making the wall very stiff at the base. The piles are short and act as columns. The material underlying the riprap is tenacious mud, sand and gravel, the dredging being carried to —30, deep enough to remove most of the softer material.

Thus, local conditions sometimes differ so much that some modification or other is suggested in many cases. This is particularly true of the lower East River water front of Manhattan below Corlears Hook.

Of the different types of cross-sections with their modifications, built upon a soft or deep mud bottom, there are 17,343 ft. of the earlier types built prior to the year 1899, and 5,680 ft. of the later types built since 1899.

Summarizing the foregoing, the length of sea wall built between 1871 and 1905 under the different types (shallow and deeper rock, from bottom, and soft bottom) is 30,575 ft. or 5.79 miles.

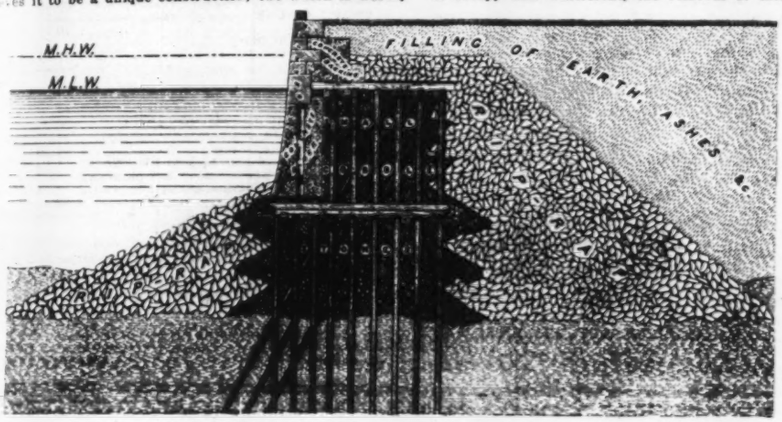
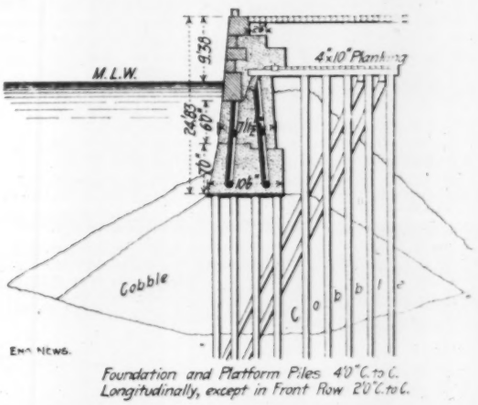


FIG. 11. (1876-1898.) NARROW CONCRETE BLOCK WALL ON THREE ROWS OF PILES IN RIPRAP EMBANKMENT; BACK-FILLING RETAINED BY RELIEVING PLATFORM.



Foundation and Platform Piles 40" C. to C. Longitudinally, except in Front Row 20" C. to C.

Fig. 12. (1899.) Wider Concrete-Block Wall on Four Rows of Piles Without Binding Frame.

FIGS. 11 AND 12. STANDARD BULKHEAD CONSTRUCTION IN SOFT BOTTOM.

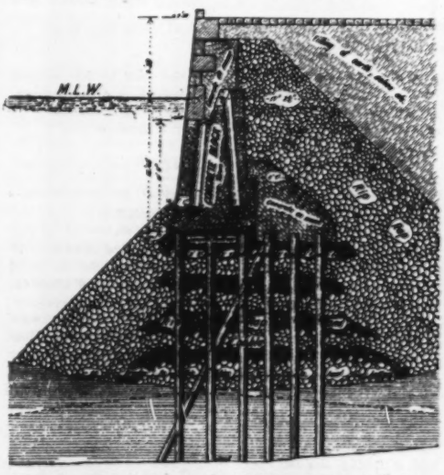


Fig. 13. Recent Design for Bulkhead in Soft Bottom Without Relieving Platform; Rector St., North River.

BEHAVIOR OF THE BULKHEAD.

Of the wall thus far built, the average depth to rock for the different types, together with the observed average movement of the wall, vertical and horizontal, is as given in Table I.

With reference to these results it must be noted that no continuous or systematic observations of the movements of the wall have been made, excepting at such locations as indicated abnormal or unusual movement. At other locations, observations have been made at odd intervals; at still others, no observations at all have been made, but generally the amount of settlement has been detected when levels preliminary to laying pavement have been run over the coping. The results, shown above, therefore, cannot be taken as representative, but are given more for the purpose of showing what may be expected under similar conditions.

COST OF BULKHEADS.

The cost of the sea wall varies greatly owing to the broad range of variation in conditions along different portions of the water front. The examination of the river bottom, the removal of old structures as well as buildings, cribs, piers, sewers, etc., building temporary or permanent sewers back of the bulkhead, building temporary approaches to piers and bulkheads, building temporary bulkheads to retain the filling at the exposed ends of a section of improvement, removing and replacing other structures, filling in, grading and paving, all enter into the element of cost to a greater or less extent according

TABLE I.—DEPTH TO ROCK AND OBSERVED MOVEMENTS OF MASONRY BULKHEADS.

Type of Section.		Depth of Rock. Feet. Min.	Max.	Av.	Settlement or Vertical Movement. Inches. Min.	Max.	Av.	Deviation from Line of Horizontal Movement. Inches. Min.	Max.	Av.
Shallow rock section	N. R.	30	30	30	0	1	½	0	—1	....
	E. R.	11	25	18	0	0	0	0	—6	....
Deep rock section	N. R.	30	45	40	0	1	½	¾	—¾	¾
	E. R.	25	35	28	....	....	....	....	....	....
Hard or firm bottom	N. R.	None.	None.	None	....	....	....	....	....	....
	E. R.	30	113	71	¾	2	1¾	1	7	4
Soft bottom or deep mud	N. R.	40	168	85	*0	4 ft.	8	0	2.1 ft.	5¾
	E. R.	35	163	80	0	3	1¾	2½	5	4½

The horizontal deviation is marked minus (—) where the movement was shoreward.
*In this class shoreward movements of 0.2 ft. to 1.8 ft. have also been observed.

to location, and constitute an item called *general charges*, which must be added to the cost of dredging for the wall area and the cost of the permanent retaining structure in order to determine the total cost of the wall. It will be readily understood that aside from the wide range of variations thus presented, the actual operations in the construction of the wall itself are more or less affected by the same features which enter into the general charges as well as by the relatively cramped or crowded condition of the immediate locality; in fact, to such an extent as to sometimes make the manipulation and operation of floating plant a very serious problem; for it must be borne in mind that the work of these improvements must be so conducted as to avoid any interference with established lines of commerce or traffic. The operations thus rendered necessary, no specific account of which is made in charging up the cost, sometimes result in jumping up the cost 50% or more. These facts are alluded to by way of explanation in accounting for some of the wide differences in cost between the different sections.

Table IV., a summary of cost for the Warren St. section of the bulkhead wall built under the prevailing type for soft bottom prior to 1899 shows the distribution of cost per running foot over the various details of construction, including the accessory work.

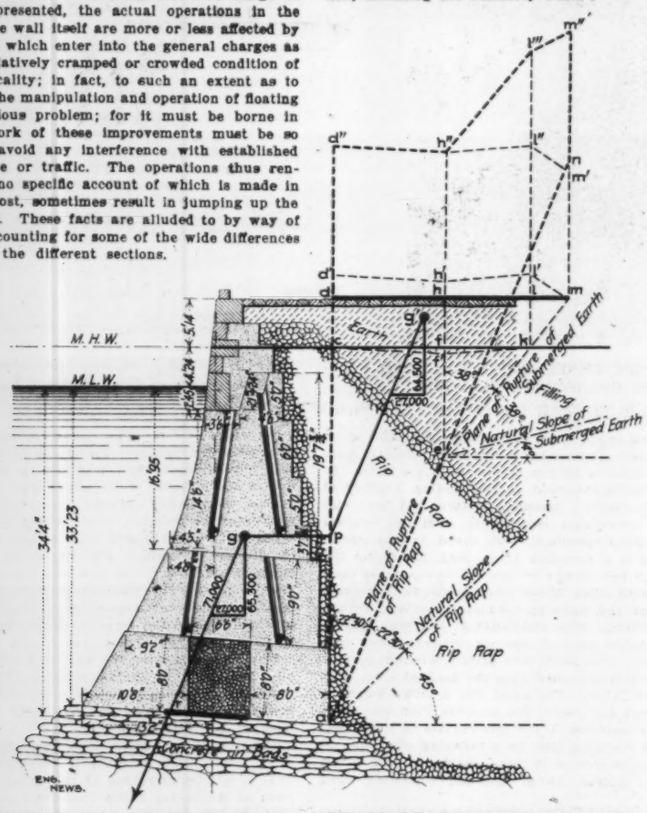


FIG. 14. BULKHEAD AT CEDAR ST., SHOWING METHOD OF GRAPHICAL ANALYSIS USED BY NEW YORK DOCK DEPARTMENT.

In the following Table II. the cost is presented under two headings, cost of the wall proper (including dredging off the wall area and construction of the retaining structure), and general charges. The sum of the two for any particular section represents the total cost *per lineal foot* of the *completed* improvement. For the sake of brevity, but three general types will be considered—the rock bottom type, the hard or firm-bottom type and the relieving-platform type, eliminating from the comparison all sections that have involved any very unusual features in the construction.

Table II.—Cost of Masonry Bulkheads per Lineal Foot.

	Min.	Max.	Av.
Rock-Bottom Type:			
Wall proper	$166.89	$313.83	$290.00
General charges	33.13	111.50	47.00
Completed improvement	252.94	373.11	307.00
Firm-Bottom Type:			
Wall proper	198.42	269.21	238.00
General charges	24.40	.....	58.00
Completed improvement*	241.82	366.34	296.00
Relieving-Platform Type:			
Wall proper†	217.28	392.27	287.00
General charges	77.83	310.62	206.60
Completed improvement	304.83	572.72	491.30

*There are no wholly completed sections of this type, consequently the above figures do not include full pavement.
†The average cost for this type of wall prior to 1899 was $288 per lin. ft.; the average cost of the modified type used subsequent to 1899 has been $278.60 per lin. ft. Of the relieving-platform type, 11,963 ft. have cost less than $300 per lin. ft. for the wall proper, and 5,259 ft. have cost more than $300 per lin. ft.

For an analytical consideration of the cost of the wall proper (dredging and retaining structure) the accompanying Table III. is given, based upon actual performance in the matter of cost per running foot for the principal items of construction.

In the cost per running foot for the rock bottom section type of wall all piles and timberwork are, of course, eliminated, while the cost of concrete and masonry is greater; but the principal items of difference are:

Pumping off rock and tubbing, which costs about .....$73.80 per running foot.
Bag concrete foundation, which costs about ..... 48.30 per running foot.

COST OF CONCRETE BLOCKS.

As stated before, the blocks in the sea wall vary in size from 30 to 95 tons, and in length on the face from 6 to 18 ft. They are made at the department yards in mold boxes with sides built of 2 × 6-in., tongued and grooved, planed spruce, battened vertically with 3 × 12-in. spruce, and trussed horizontally on about 4-ft. centers, with ⅞-in. horizontal steel rods chocked at the center a few inches from the faces of the verticals. Chain grooves for handling, with heavy 2-in. stud link chain slings, are cored in the bottom and sides with a diameter of about 12 ins. The inside surfaces of the mold boxes are sludged with hot tallow.

It costs about $1.20 per cu. yd. for erecting, sludging and stripping molds.

The unit of comparison in concrete work is a batch—the quantity made with one barrel of cement. The concrete being a 1 : 2 : 5 mixture, one batch is equivalent to ⅘ cu. yd. and, with a gang of sixteen men, with two men ramming in the molds, thirty batches or 48 cu. yds.

Table IV.—Itemized Cost, Warren St. Bulkhead.

		Per
Dredging		
Riprap and cobble		
Piling and timber-work:		
Vertical piling	$47.40	
Bracing piles	6.88	
Binding frames	9.52	
Sawing off piles	4.76	
Longitudinal caps	5.14	
Transverse caps	8.57	
Decking	2.74	
Masonry:		
Concrete blocks, fabrication	$23.80	
Setting concrete blocks	9.35	
Filling chain-holes	1.66	
Granite facing	39.25	
Concrete backing	23.35	
Coping	10.91	
Backing log in place	.75	
Pointing	1.34	
Total for retaining wall proper		
General charges:		
Examination of the river bottom	$0.66	
Removal of old wall	18.27	
Filling in and grading	10.19	
Temporary paved approach to Pier No. 19	1.19	
Temporary tool house, fences and plumbing	.97	
Levels on and examination of the wall	.14	
Paving	62.20	
Total cost of improvement		

are an ordinary day's work. The cost, therefore, of concrete blocks will average for

	Per batch.	Per cu. yd.
Labor in mixing and depositing concrete, about	$1.00	$1.60
Materials, about	2.90	4.64
Erecting, sludging and stripping molds, about	.75	1.20
Total cost, ready for shipment	$4.65	$7.44

The cost of setting a block includes derrick charges, transportation, towing, material and labor for mattresses, diver's time, and all other labor charges, and is obviously very much the same for blocks differing considerably in size. The cost, therefore, per cubic yard would be misleading and unfair. A more rational comparison is the cost of setting per running foot of wall, and this averages about $38, making the cost for setting and 8-ft. block weighing 80 tons, the present relieving-platform standard, about $304. Then the total cost of the blocks in place becomes, per 80-ton block:

Cost of block fabricated	$286
Cost of setting block	304
Total cost of an 80-ton block in wall	$590

NOTES ON TIMBER IN THE CONSTRUCTION OF THE BULKHEAD WALL.

The question has frequently been asked, why does the Dock Department risk a permanent work by placing timber above mean low water? The first answer to this question is that the question itself begs the question, for it assumes that any timber above mean low water is in a position to yield to decay; but experience and investigation of the Department do not confirm this theory in so far as it applies to structures in close proximity to the influence of the tide.

Wherever excavations have been made in the rear of the wall after the filling has been deposited, the tide has been found flowing over the timber; but in order to demonstrate this matter as a fact beyond question, the

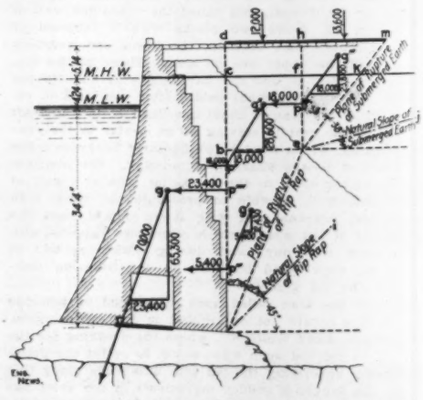


Fig. 15. Earlier Method of Graphical Analysis of Bulkhead Wall.

TABLE III.—ANALYSIS OF COST OF WALL PROPER, FOR THREE MAIN TYPES OF MASONRY BULKHEAD.

Item.	Rock Bottom Type. Min.	Max.	Av.	Hard or Firm Bottom Type. Min.	Max.	Av.	Relieving-Platform Type. Min.	Max.	Av.
Dredging	$6.60	$107.00	$30.00	$11.00	$44.00	$32.00	$13.00	$62.00	$30.00
Riprap and cobble	4.50	12.50	10.40	12.50	19.50	16.00	24.00	84.00	44.00
Piling and timber work	.....	.....	.....	49.00	62.00	56.50	72.00	139.00	89.00
Concrete and granite	156.00	309.00	254.00	125.00	133.00	129.50	89.00	139.00	109.00

neer-in-Chief at that time, Mr. George S. Greene, about twenty-five years ago caused two tide s to be set up in the rear of the wall on the y St. section; one about 24 ft. in the rear of the that is, at the inshore edge of the relieving platn and one about 80 ft. in the rear. The points at h these tide gages were established were in the mid- of a completed length of wall about 2,000 ft. long, pletely filled in behind. A similar tide gage was also ed on the pier immediately in front of the wall. The rd of the gage placed in the rear of the timber platm showed that the tide flowe over and around the tim- in the wall to very nearly the same extent that it uld if they were outside. The gage 80 ft. inside the l showed that the tidal flow is somewhat affected by sing through a greater distance of filling, causing a ater retardation of flow. The curves for all three ges, being plotted, showed that the tide behind the wall s a little later than that outside and that low water inde was a little higher than low water outside, and high ater inside a little lower than high water outside, he difference being about 0.4 of a foot. The gage 80 ft. side the wall showed this difference to be about 1 ft., that is, low tide did not fall within a foot as low as low tide outside the wall, nor high tide rise to within a foot s high as high tide outside. Manifestly, the effect of this action of the tide would be to increase the length of time that the timber is submerged, and decrease the length of time that it is not submerged. If the voids and spaces in the stone and cobble filling should in the course of time become silted up so as to oppose greater resistance and cause greater retardation, the effect would be similar to that shown by the gage 80 ft. inside the wall, increasing the time of submergence and decreasing the time of non-submergence. From the records of the tide gage outside of the wall, conducted over a period of three years, it appears that if the timber had been outside of the wall it would have been submerged about 66% of the time and not submerged about 34%. The records also show that the earth and stone filling above the timber is saturated and submerged by the tide to nearly the height of mean high water or to about 3 ft., and above this there are about 5 or 6 ft. of earth filling.

In order to ascertain the amount of evaporation under the circumstances of 8 ft. depth of filling with the lower 3 ft. constantly saturated, experiments were made by carefully weighing timber exposed to similar conditions before and after the experiment, and it was found that after the timber had become water-soaked its weight remained practically unchanged; showing an absence of evaporation, due to the tidal flow always keeping the timber wet both from tidal submersion and the saturation of surrounding filling.

The experience of practical men engaged in building timber structures along the water front shows that timber does not rot below half tide. This is certainly the case in piles and in face timbers of crib bulkheads; and the experience of the Department has been that in the rear timbers of such bulkheads which are buried in the earth filling the line of decay is considerably higher than the line of half tide, and all the experience of the Department in tearing up old work and making repairs, corroborates this statement.

In December, 1877, two specimens of timber were obtained from some old cribwork uncovered by an excavation being made at the corner of Washington and Spring Sts.; one specimen was taken from the height of 0.7 of a foot and the other from a height of 3.7 ft. above mean low water. The structure in question existed on maps as far back as 1804 and both timber specimens were in a perfect state of preservation. When the elevated railroad was being built in 1879, near South Ferry, a piece of timber was taken from the excavation for foundations at about 360 ft. from the present bulkhead at an elevation of 2.7 ft. above mean low water. This specimen showed the sap wood on one side to be decayed, but the heart wood was sound. Old maps show that this timber was probably placed where it was found about 125 years ago.

It is, therefore, reasonable to infer that timber in such close proximity to the water front as is used in the bulkhead wall construction would be perfectly safe from decay up to a height of at least 2½ ft. above mean low water; and as the construction of the bulkhead wall where the timber platform is used is practically the same everywhere along the water front built with similar material and in a similar manner and under similar conditions, it is certainly reasonable to conclude that similar results would be obtained by placing tide gages at other similar points.

GRAPHICAL ANALYSIS OF BULKHEAD WALLS.

The method used in the Department at the present time for designing rock sections of the bulkhead wall is believed to be new. The literature on the subject or sea walls is very sparse and far from satisfactory. Any correct analysis for the purpose of determining a resultant thrust at the base is attended with considerable complexity owing to the varying densities or weight per unit of the back filling or filling behind the wall. Accordingly, a couple of years ago the writer, with Mr. D. C. Serber's very able assistance, gave this subject a thorough overhauling with a view to determining a short graphical, substantially accurate and rational method of analysis. The conclusion reached seems to fulfill these requirements very well. Nearly all authorities agree as to the general method of determining the resultant in a retaining structure. But their conclusions presuppose ideal conditions which, it is safe to say, are never realized in actual practice; and no one knows how wide the departures from these conditions really are, more especially in the sea wall with the tide backing in behind into the filling, an unknown and necessarily variable distance. The subject is clouded with a great deal of uncertainty, and after all it resolves itself into one of those matters in which experience must be a most valuable guide; for, usually, the result accomplished, namely the cross-section profile, is more than likely to bear evidences of analytical control modified more or less by the dictates of judgment or personal equation.

The conditions given are an approximate cross-section of submerged or of non-submerged wall, submerged sections and non-submerged sections of riprap filling and of earth filling and a surcharge of 1,000 lbs. per sq. ft. (see Fig. 14, representing the section used at Cedar St., E. R.).

Erecting a perpendicular a d, laying off the prism of maximum thrust for riprap by the plane of rupture a e, prolonging the line a e to n, and denoting the corresponding prism for the superimposed submerged earth filling by the plane e k, which we shall prolong to m, neglecting the change in plane of rupture for non-submerged earth filling, we find that the limit for surcharge to be considered at the surface grade is contained between the intercepts d and m. Considering now everything below mean high water as submerged and everything above mean high water as non-submerged, let us conduct the analysis on the following assumpties:

Weight of riprap in air, 107 lbs. per cu. ft.; Submerged riprap, 70 lbs. per cu. ft.; Earth filling in air, 110 lbs. per cu. ft.; Submerged earth filling, 66 lbs. per cu. ft.; Surcharge, 1,000 lbs. per sq. ft. of surface.

Procedure: 1. Determine the weight of the submerged earth filling c e k, and replace it with a corresponding weight of submerged riprap. The top surface of the latter will then be c f' k. 2. Determine the weight of the non-submerged earth filling c d m k and replace it with a volume of submerged riprap of equal weight, and allow it to take its position upon the first reduced volume of submerged riprap. This second volume will then be c d' h' l' m k f'. 3. Take the surcharge of 1,000 lbs. per sq. ft. and erect upon the top surface d' h' l' m of this imaginary bank of submerged riprap a prism of submerged riprap of such a volume as shall equal in weight the surcharge; the upper surface of this reduced volume will then be d'' h'' l'' m'. We now have the area a d'' h'' l'' m' m e a representing in volume all of the back filling used in exerting pressure against the wall reduced to one homogeneous material, namely, submerged riprap weighing 70 lbs. per cu. ft. But in order to avoid the complication arising from a consideration of the two planes of rupture a e and e m, and, as we have already reduced the back filling to riprap, let us adhere to the plane of rupture for riprap, namely, a n, and shift the material represented by the area e n m to a new position to form part of the prism limited by the plane a n, making h'' the new position for e, l'' l''' the new position for k l', and m' m'' the new position for m n. The volume to be considered having the weight of submerged riprap, is now represented by the area a d'' h'' l''' m'' n a.

The center of gravity of this area is found to be at g', and combining the weight of the mass through g' with its horizontal component, we find the horizontal thrust on the back of the wall to be 27,000 lbs. applied at the point p. Combining this thrust with the weight of the wall represented by the vertical line 65,300 lbs. through its center of gravity, we obtain the resultant, 71,000 lbs., which passes through the base at the point r.

In determining the center of gravity of the wall section it is of course necessary to consider the reduction in weight due to displacement below mean high water of the two materials, concrete and granite, which enter into its construction, the weight of the non-submerged portion above mean high water, the weight of the submerged riprap on the steps in the rear of the wall, the weight of the superimposed volume of non-submerged riprap and of earth filling.

In this method, which it is believed has never been published before, no further merit is claimed than that it is shorter, simpler and just as nearly accurate as any other method. It is checked by the fact that the results closely agree with those obtained by tracing the pressures through the different materials, as illustrated in Fig. 15.

Applying the analysis to the same section of wall, and laying off the planes of rupture for riprap a e and for submerged earth e m, as before, let us, first, consider the pressure of the volume represented by the area e h m e with its superimposed surcharge. Combining the centers of gravity of three different densities represented; that is, the submerged earth filling e f k, the non-submerged earth filling f h m k, and the surcharge h m, 13,600 lbs., we obtain the resultant weight, 23,800 lbs., through the resultant center of gravity g''. Combining this weight as a vertical force through g''', with its horizontal component, we get the resultant thrust on e h, from which we obtain the horizontal thrust, 18,000 lbs., against the vertical plane e h at the point p. Again, in the area b d h e combine the weights and centers of gravity of the different materials, namely, submerged riprap b c e, submerged earth filling c f e, non-submerged earth filling c d h f, and superimposed surcharge d h equal to 12,000 lbs., we obtain the resultant weight 28,600 lbs. through the resultant center of gravity g''. Combining this force with the horizontal thrust 18,000 lbs., we obtain the direction of the resultant which strikes the line a d at the point p'' with a horizontal thrust of 18,000 lbs. Finally, determining the weight and center of gravity of the submerged volume of riprap represented by the area a b e and decomposing the resultant thrust with this weight 12,430 lbs., as the vertical component through the center of gravity g', we obtain the horizontal thrust 5,400 lbs. applied at the point p'''.

Now combine the two horizontal thrusts at p'' and p''', determine the resultant horizontal thrust 23,400 lbs. applied at a point p'''', and combine this resultant horizontal thrust with the weight of the wall, determined as before through its center of gravity g, we get the resultant thrust on the base of the wall 70,000 lbs. applied at the point r.

A comparison of the two methods show a very close agreement both in the amount, direction and point of application r of the resultant thrust.

THE INTERNATIONAL RAILWAY CONGRESS.

The technical proceedings of the seventh meeting of the International Railway Congress were of considerable importance and interest, and we present herewith an abstract of the proceedings, with the conclusions formally adopted upon the various subjects considered. The opening proceedings and ceremonies were dealt with in our issue of May 11, and in another column we give some particulars of the entertainments and excursions provided, and the important social functions. In our supplement will be found a classified list of the very comprehensive exhibits at the Railway Appliance Exhibition, which was one of the important features of the Congress.

SECTION 1.—TRACK AND WORKS.

Timber Ties.

The first report was by Mr. Hausser, Chief Engineer of Maintenance of Way of the Southern Ry. of France, and dealt with the selection of wood and processes of preservation. Treated ties are generally used in Europe, and dating nails and statistical accounts enable a close record of their life to be kept; but there is little information as to the life of untreated ties. Various methods are adopted to prevent the mechanical destruction of the timber by the rails and fastenings. In discussing the strength and soundness of timber, Mr. Muntz stated that in France it is sometimes attacked by a worm in such a way that, while it becomes unsuitable for building purposes, its strength is not affected. Mr. Kruttschnitt (Southern Pacific Ry.) remarked that similar conditions exist occasionally in the cypress of Louisiana. As to the covering of ties with ballast in warm countries, Mr. Cartault (Paris, Lyons & Mediterranean Ry.) approved of covering them to a depth of 3 or 4 ins., but the American speakers disapproved of such a practice where the climate is both moist and warm, although in warm, dry districts it may be advantageous. This latter is the experience in both France and India. Mr. Dudley remarked that yellow pine ties will last ten or twelve years in the northern states, but only four or five years in the southern states, while on the Panama Ry. they will last only about eighteen months. As to the effect of ballast laid upon the ties in relation to automatic block signaling, Mr. Kruttschnitt remarked that slag ballast has given trouble in the past, but that modern improvements in signal apparatus have overcome this difficulty.

Another report on the same subject was presented by Mr. J. W. Kendrick, of the Atchison, Topeka & Santa Fe Ry., and was a summary of American practice and experience. Most of this information has already been given in various reports and papers published at different times in Engineering News. The discussion showed the importance of proper seasoning of the ties, a practice which is much more common abroad than in this country. As to the preservative treatment, Mr. Cartault stated that the Paris, Lyons & Mediterranean Ry. (France) uses creosote; oak ties take about 14 to 15 lbs. each, and

last 15 to 20 years; beech ties take as much as 45 lbs., and last 20 to 25 years. These ties cost about $1.60 each, when treated. The creosote oil contains 10 to 25% of naphthalene and 67% of phenol; the former is considered to help in closing the wood cells, and a certain percentage is added to all creosote which falls below the standard. Mr. Von Schrenk, of the U. S. Department of Agriculture, questioned the value of the napthalene, and stated that in England a minimum of 6 to 8% is specified, while in Denmark a certain maximum is specified, and in the United States the maximum runs up to 60%. Another speaker remarked that the Finland Government Railways and the Northeastern Ry. of England both exclude naphthalene in their specifications. It was finally resolved that the best results are obtained with from 10 to 25% of napthalene in the creosote. Mr. Dufour stated that, on the Netherlands Railways, beech ties treated with the zinc-creosote process last from 15 to 20 years.

In regard to the protection of ties against wear by abrasion, the use of tie-plates with screw-spike fastenings was referred to, and this combination is used on several French railways. The screw spike was considered by the foreign engineers as far superior to the American spike, and Mr. d'Herbeline (Paris & Orleans Ry.) thought that the wear of ties which he had noticed on American railways could be prevented by the use of screw-spikes. Mr. Dawson (London & Northwestern Ry.) and Mr. Louth (Great Western Ry.) presented the English view in favor of bull-head rails supported in cast-iron chairs. Mr. Kendrick remarked that he was experimenting with wooden tie-plates or shims on rail-worn ties. The necessity for forest preservation in this country was referred to briefly, and Mr. Gifford Pinchot, of the U. S. Forestry Bureau, remarked that the preservative treatment of ties must be supplemented by the establishment of new forests for future timber supply. The steam railways alone consume about 110,000,000 ties annually. There was no reference to the numerous recent experiments with concrete ties and steel ties in this country, or to the very extensive use of metal ties in other countries.

A short report by Mr. F. J. E. Spring, formerly Chief Engineer of the Railway Department of the Government of India, dealt with the deterioration of wooden ties in tropical countries, and was supplemented by lists of the replies of individual railways (principally in India) to a series of nearly 50 questions concerning their practice and experience. At the close of the discussion, the following conclusions were adopted:

1. The preservative treatment of ties in order to lengthen their life is to be generally recommended. The selection of the antiseptic and the method of carrying out the operations depends on individual conditions.

2. Creosote seems to be the best preservative for ties; it has been successfully tried for a longer time than any other antiseptic and the results have proved that creosoted ties will last in main track service many times as long as untreated ties.

3. Either hard or soft woods may be used, the selection depending on local conditions.

4. Specifications must be exact, and great care should be exercised by the inspector before accepting ties for treatment. The accepted ties should be piled at least 6 ins. above the ground in open stacks in such a manner as to allow free access of air and light. The ground surrounding the piles of ties should be kept clean and free from decaying matter.

5. The uncovering of the ties by removing the ballast from the top surface does not appear to diminish the life of the wood even for untreated timber, and it has the advantage of enabling the track inspector to discover at once any defects in the track fastenings, etc. In some special cases, and especially in warmer countries, it may be useful to cover the ties with ballast.

6. It is of importance to combine rigid inspection in accepting ties with great care in the selection of ballast; the latter must be permeable, must be capable of being well packed and the packing well maintained, and give good adhesion between the tie and its seat. As far as this is concerned, the measures which are best for the preservation of the wood are also best for the stiffness of the track.

7. In order to prevent deterioration of the ballast and at the same time help to preserve the ties, the careful drainage of the roadbed cannot be too carefully insisted upon in order to insure that water may run off properly.

8. To prevent mechanical wear, of the ties by the rails, it is of the greatest importance to fasten the rail to the tie in such a manner as to prevent as much as possible all vertical, lateral and horizontal movement between the two. The American method of using spikes only will not accomplish this. Lag screws seem to be necessary to attain satisfactory results.

9. It is only by keeping careful and accurate records of the number of ties treated, the manner in which they were treated, and where and when they were placed in the track, together with a record of when they were taken out of the track, that it is possible to determine whether any one particular treatment is giving satisfaction and is a good investment. Every railway management using treated ties is urged to have them all marked, preferably with dating nails, and to institute a careful system of records at the earliest possible time.

Rails for Lines Carrying Fast Trains.

There were three reports on this subject by Mr. P. H. Dudley, Inspecting Engineer of the New York Central Ry.; Mr. Van Bogaert, of the Belgian State Railway Department; and Mr. J. W. Post (recently deceased), Chief Engineer of Permanent Way of the Netherlands State Railways. The conclusions of all three reports were presented for discussion, but were so numerous that, on motion of Mr. Descubes (Eastern Ry., of France), a committee was appointed to condense the three sets of conclusions into one concise set for consideration by the meeting. This committee was composed of Mr. Dudley, Mr. Van Bogaert and Mr. Dufour (of the Belgian Railway Department). The report by Mr. Post related to five European railway systems, and some of the information given we tabulate below.

In spite of the material increase in the speed and weight of trains during the past few years, the lighter rails are still considered safe if the track has careful maintenance; this is expensive, and the expense increases both with the number and speed of trains. The remedy lies in strengthening the track by means of stiffer rails, improved joints and fastenings, a larger number of ties, more and better ballast, and better drainage of the roadbed. Very little progress has been made in the improvement of joints, the ties are already as close together as is desirable (averaging 27½ ins.), and the cost of ties and ballast is increasing. Under these conditions, Mr. Post considered that heavier and stronger rails must be looked to as the most practicable improvement for track carrying heavy trains.

Mr. Dudley's report was long and comprehensive, illustrating the standard track construction of many American railways, and presenting the results of his investigations as to the manufacture, chemical composition and form of section of rails; also as to the fiber stresses and bending moments in rails under the wheels of locomotives and cars in motion. The replies to enquiries sent to various American railways indicate a general opinion that improvements are needed in the present methods of rail manufacture, an opinion that has been very forcibly expressed at the meetings of the American Railway Engineering and Maintenance of Way Association, as has been noted in Engineering News. The report also dealt with the micro-structure and chemical composition of rail steel, and stated that high-carbon 100-lb. rails on the New York Central Ry. have carried 250,000,000 tons with a wear of only 1-16-in., while frogs made of these rails last 2½ to 3 years in places where frogs of softer steel wear out in 6 to 8 months. Nickel steel rails are in use on the New York Central Ry., Baltimore & Ohio Ry. and Pennsylvania system, and some of the latter have outworn two or three ordinary rails. The questions of joints and fastenings were also discussed, with other matters relating to track construction, and having therefore a direct bearing upon the question of rails.

The following conclusions were adopted, and the "improvement in loading the subgrade" referred to in conclusion. No. 1 has reference to use of a leading truck to hold or load the rail in advance of the driving wheels. In foreign countries, however, the importance of this is not generally recognized, engines without trucks being still largely used, and the conclusion not adopted until after some discussion:

1. The subgrade is the foundation which must meet the effects of the moving loads, as distributed through the wheel contacts to the rail section, crosstie and ballast, and is loaded and unloaded for the passage of each train, and partially for each wheel. An improvement in loading the foundation increases its stability, and is followed by an increase in capacity.

2. A well-fished rail section and the foundation must it have lower strains, because the rail thus forms to some extent, a continuous beam with several supports.

3. The weight of rails tends to increase with the Track with heavy rails requires less maintenance and renewal. The rail is less subject to wear and bre With carefully maintained tracks, good rolling stock well balanced locomotives the necessity for emp heavy rails is less urgent.

4. Enlarging the head of the rail permits an incre in the bearing of the fish plate, the wear on the surfa of contact is, consequently, reduced, and with it al the deformation of the joint. For this purpose the st of the fish plates should be almost as hard as that of the rails, with the limiting condition of avoiding britt Well designed fish plates help by their grip at the ends to transmit from one rail to the other, the bending moments which are caused by the motion of the locomotives and cars.

5. The usual tests of quality (by tension, bending or impact), and the ordinary methods of acceptance enable us to obtain a steel suitable for lines with fast trains, but they are insufficient for American railways, where the load on the wheels is greater. It is, however, desirable to seek for methods of investigation to detect flaws. There is a tendency to watch more carefully the physical treatment of rails, by controlling the temperature during rolling, in order to obtain a fine grained metal. Some improvements in the method of manufacture tend to reduce the laws in the ingots, and lead us to the hope that the number and length of these flaws will be reduced in the finished rails also.

6. To obtain a good quality of steel it is desirable to roll T rails with flanges at least 0.5-in. thick at the edges.

7. The metal of the rail should be sound, of fine grain, and should have an elastic limit of 40 to 42 kilos per sq. m.m. with an elongation of 10 to 15%, measured on a length of 50 mm. The test piece should be taken from the head of the rail.

8. Nickel steel is not used for rails in Europe. In America, where the wheel loads are greater, nickel steel is being tried on specially busy tracks.

9. Several arrangements of the joints of T rails with angle bars, either suspended or supported, are in use; both give good results. In America a successful attempt has been made to reduce the length of expansion joints on heavy rails of great length.

10. Welded joints are not to be recommended. It is desirable to use rails of great lengths; 18 meters (59 ft.) is a length which has become usual in Europe; in America the standard length is 33 ft.

11. Creeping can be successfully prevented.

Improved Frogs.

This brief report was by Mr. C. W. Buchholz, Consulting Engineer of the Erie Ry. It showed that in the United States spring-rail frogs are in general use where one track is used much more than the other, as on main lines where the connections to sidetracks are not extensively used. For crossovers or diamond crossings at terminals, slip switches with movable point frogs are invariably used; but at junctions or where it may be necessary to switch from one running track to another (and where there is plenty of room), a series of switches with long frogs is frequently used. It is not considered safe to use a movable-point frog above No. 12, and where fast running has to be considered, the frog is increased to No. 20, and a rigid frog is used. As to grade crossings of tracks, the report stated that "there has never been any device invented that will avoid the shock of the gap." As a matter of fact, several devices have been invented and a few have been tried in service, but no satisfactory results have yet been attained. The report concluded with a mention of manganese-steel frogs, which prevent wear and are a valuable substitute for spring-rail frogs where rapid movement from one track to another is necessary.

Spring-rail frogs are as yet very little used abroad, but in the discussion Mr. Fraser, of the New South Wales Government Railways, stated that they are being used on these Australian rail-

	Danish State Rys.	Dutch State Rys.	Dutch Ry. Co.	Russian State Rys.	St. Gothard Ry.
Lightest rails for fast traffic	63 lbs.	68 lbs.	68 lbs.	66 lbs.	74 lbs.
Average spacing of ties	28¾ ins.	29½ & 35½ ins.	34½ ins.	28 ins.	30¾ ins.
Ultimate tensile strain of rail steel	78,226 to 92,448 lbs.	85,337 to 92,448 lbs.	85,337 to 92,448 lbs.	85,337 lbs.	85,337 lbs.

...gs. Mr. Ramsey (Chicago, Peoria & St. Louis ...) uses spring-rail frogs where trains run at ...h speed, without any limit as to speed of ...ing. Mr. Ashby (Lehigh Valley Ry.) uses them ...ere the speed is limited, but where all trains ...p he prefers rigid frogs with manganese steel ...nts. After a brief discussion the following con...sions were adopted:

On all main lines carrying heavy traffic with axle ...dings on the locomotive of over 50,000 lbs., and with ...ds on the rolling stock reaching as high as 40,080 ...s. per axle, the "spring rail frog" or the "hinged ...pring frog" may be used with perfect safety, where the ...affic on the side tracks connecting with the main track ...very slight compared with the main traffic.

The "movable point frog" may be used at all terminals ...here the space for crossing from one track to another ...s limited, but where space permits, and where high ...peed is necessary, a series of switches, with the best ...designed switches and fixed frogs are preferable.

Concrete and Reinforced Concrete.

There was a long report on American practice by Mr. John F. Wallace, Chief Engineer of the Panama Canal Commission, and also two reports by Mr. Kareischa, of the Russian State Bureau of Consulting Engineers of Maintenance-of-Way, and Mr. Ast, of the Emperor Ferdinand Northern Ry., of Austria. In the discussion, some of the foreign engineers considered that the use in railway bridges should be limited to spans of 23 ft. Mr. Rabut spoke of the great facility of the double-tracking of the Paris Belt Ry., owing to the use of concrete instead of metal for the overhead bridges. The following conclusions were adopted:

1. Reinforced concrete has received many and important applications on railways. Both from the technical and economical points of view, it can fully and successfully compete with masonry and timber or steel construction.

2. Tests of reinforced concrete structures, theoretical researches on the question, and the results of practice, justify the conclusion that such structures need not cause any apprehension, and their application is recommended to railway administrations.

3. Railway practice shows that carefully built reinforced concrete structures give excellent service and require almost no maintenance. For this reason the use of reinforced concrete should be recommended, even if the cost of construction should, exceptionally, be higher than for another system of construction.

4. Reinforced concrete structures are an especially great help in countries where materials, stone or iron, are difficult to be obtained in large sizes.

5. Reinforced concrete permits the rapid building of structures with readily obtained materials, and this avoids the necessity, so trying in practice, of giving special orders to shops.

SECTION 2.—LOCOMOTIVES AND ROLLING STOCK.

Locomotives of High Power.

Two reports on this subject, relating to American and foreign practice respectively, had been prepared by Mr. J. E. Muhlfeld, General Superintendent of Motive Power of the Baltimore & Ohio Ry., and by Mr. Sauvage. The summary or conclusions presented are given further on. The discussion opened with the subject of automatic stokers for locomotives; these are in experimental use on the Great Western Ry., England, but Mr. F. G. Wright, Assistant Locomotive Superintendent, stated that the results were not very satisfactory. They are also in use on the Cleveland, Cincinnati, Chicago & St. Louis Ry. The general opinion was that these devices have not yet shown any material economy in fuel consumption, and Mr. Muhlfeld expressed the opinion that locomotives could be worked to their highest capacity without their use. Mr. J. F. Deems, Superintendent of Motive Power of the New York Central Ry., spoke in favor of narrow fireboxes, as wearing better than wide fireboxes, and this has also been the experience on the Chicago, Milwaukee & St. Paul Ry. Wide fireboxes are sometimes necessary, however, in order to obtain sufficient grate area.

Mr. Sauvage favored the compound system, but some of the American speakers were doubtful as to its ultimate advantages, the decrease in fuel consumption being sometimes nearly counterbalanced by the increase in maintenance expenses. Mr. Vaughan, of the Canadian Pacific Ry., has had considerable experience with two-cylinder compounds, but believes that better results can be obtained by superheating than by compounding. Over 100 locomotives equipped with superheaters will soon be in operation on American railways. Mr. Lovell spoke of the investigations made on the Atchison, Topeka & Santa Fe Ry. to determine the comparative merits of simple and compound locomotives. The latter can haul heavier loads with less fuel, and there is very little difference in the cost of maintenance; where this cost is higher for the compounds it is chiefly due to the fact that the engines have greater power and do more work than the simple engines. In certain cases, the simple engines have much higher maintenance expenses owing to the necessity of forcing the fire to give the necessary steaming capacity. Mr. McIntosh, Superintendent of Motive Power of the Central R. R. of New Jersey, also favored the compound system, and thought it capable of further improvement. Mr. Moffre, of the Southern Ry. of France, was very strongly in favor of compounds, and finds an economy of 20% in fuel consumption; he favored the four-cylinder balanced system either with compounding or with superheating. Mr. Carl Steinbiss reported the results of experiments made on the Prussian State Railways with two, three and four-cylinder compounds. There are over 1,000 compound engines now in service, for both passenger and freight traffic, and they show an average saving of 10% in fuel consumption. With the exception of the starting valves, the maintenance expenses are not higher than for single engines. Very satisfactory results are also being attained with superheating on simple engines. Mr. Bowman, of the Midland Ry. of Ireland, finds that compounds average a saving of 10% in fuel, with no increase in maintenance expenses; he favored the four-cylinder system.

The question of staybolts next came up, and Mr. Gibbs spoke of the French compound engine (De Glehn four-cylinder system), now in use on the Pennsylvania R. R. The engine is remarkable as to the lightness of its parts, but has given considerable trouble with its copper staybolts, and has also had many cases of hot boxes. Mr. Laurent (Paris & Orleans Ry.) stated that copper staybolts also give trouble in France; the upper rows have had to be replaced with manganese bronze staybolts, and engineers are still seeking a better metal. But these difficulties are also experienced with the American engines belonging to his company, and appear inherent to the use of high pressure. As to hot driving boxes, he had tried American lubrication with wool waste, but derived no advantage, and has returned to the use of lubricators, which seem to him preferable. Mr. Asselin (Northern Ry. of France) stated that on his line copper staybolts had been replaced entirely with manganese bronze staybolts; the heads of these burn out more quickly than those of copper staybolts, but by being careful to replace all staybolts whose heads have burned out, whenever the engine is laid off for any reason, all objections are overcome. The use of crank axles were spoken of rather doubtfully by some of the American engineers, but the foreign engineers thought there need be no anxiety as to their safety.

The advantages of the De Glehn four-cylinder compound system, with independent valve gears for the high and low pressure cylinders, were spoken of by Mr. Wright, of the Great Western Ry., of England, and Mr. Ronayne, of the New Zealand Government Railways, as well as by some of the French engineers. The Eastern Ry. of France has now over 300 of these engines. The advantages of piston valves over flat slide valves were also discussed, and the discussion closed with mention of three enormous duplex locomotives for heavy coal trains on lines with grades of 1½ to 2%. The first of these is the Mallet engine, of the Baltimore & Ohio Ry., which we have already described. Mr. Asselin stated that the Northern Ry. of France has a tank engine with two steam trucks, each of which has a small pair of wheels at the inner end; this weighs 112 tons, and can haul a load of 1,100 tons up a grade of 1.2% at 12 miles an hour. Mr. Flobert, of the Northern Ry. of Spain, stated that he is building an engine with two boilers, and two steam trucks; it is 80 ft. long, weighs 132 tons (93 tons on the drivers), and will haul heavy trains at 12½ miles an hour on a line with long grades of 2% and curves of 984 and 820 ft. radius. The load is 15.4 tons per axle, and 3,200 lbs. per foot of track, which is the maximum that can be permitted.

The following conclusions were adopted:

The power of locomotives is more limited in Europe than in America, owing to the lower allowance of weight per axle.

European engineers generally agree that compounding admits of the construction of engines giving the maximum power and economy. This system utilizes the steam very well and does not appear to increase to any noticeable extent the cost of maintenance of locomotives; it does make the maintenance of the boilers more difficult, but that is due to their increased size and higher working pressure, which are necessary in all cases. Almost all locomotives built in France in recent years have four balanced cylinders. These engines, as well as compound engines of other systems, are also employed in other European countries. Several engineers in Great Britain and Ireland express equal satisfaction from their use and insist on the advantage of separating the high and low pressure machinery. A number of American engineers also express opinions favorable to compound locomotives; the sentiment on this matter is, however, less unanimous in the United States than in Europe.

The introduction of American locomotives in Europe and European locomotives in America has had the advantage of making known on both sides some interesting details of construction, particularly the light weight of the parts of European locomotives and the syphon and sight feed lubricators of American locomotives.

The constantly increasing use of cast steel is observed, which in the United States has even been tried for cylinders.

The use of the Walschaerts motion gear is extending in the United States. Generally speaking, all the engineers who have spoken of cylindrical valve chests appear well satisfied with them.

Tests of automatic stokers have been made in the United States and on the Great Western Ry. of England, but as yet the results have not been definite. It has also been found, both in America and in England, that without the aid of these devices, but with proper arrangements of grates, the heaviest firing necessary at the present time can be effected without difficulty.

Car Lighting, Heating and Ventilation.

A lengthy report by Mr. Banovits, Superintendent of Locomotives and Rolling Stock of the Hungarian State Railways, presented a review of European practice. The electric light was considered as preferable to other systems, on account of its efficiency, safety and low cost for attention and maintenance. Acetylene gas was objected to on account of liability to explosion, while mixed gas with regenerative burners gives equally good light. Of 159,742 cars of various foreign railways reported upon, the lighting systems were as follows:

Gas: Ordinary gas, 34.53%; part ordinary gas and part mixed gas, 3.15%; mixed gas, 20.60%; acetylene, 0.05%; total, 58.33%.

Electricity: Storage batteries, 2.42%; with one dynamo for the train, 0.03%; with a dynamo to each car, 3.23%; total, 5.68%.

Miscellaneous: Candles, 0.56%; oil, 31.60%; petroleum, 3.83%; total, 35.99%.

For heating the cars, the use of fixed or portable footwarmers is unsatisfactory, and stoves inside or outside (the latter used in Norway, with hot air conduits) are in many ways objectionable. Hot water systems are well adapted for through cars requiring independent heaters; the boiler may be heated by steam from the engine when the car is coupled into a train fitted with steam pipes. For general purposes, however, heating the cars by steam from the locomotive is the most efficient and convenient system. Of 114,468 cars of various railways (not including any American lines), the heating systems are as follows: Footwarmers, 37.43%; stoves, 9.57%; hot air (from stoves under the cars), 1.23%; hot water, 2.67%; high-pressure steam, 45.61%; low-pressure steam, 3.28%; other systems, 0.21%.

As to ventilation, there is much field for improvement, particularly in regard to the supply of fresh air. Of 136,923 cars of foreign railways, the ventilating methods are as follows: Sliding ventilator panels, 52.3%; swinging ventilator windows, 7.75%; roof ventilators, 19.80%; suction pipe ventilators (pipe laid along the roof), 0.25%; monitor roofs or clerestories, 19.47%; other methods, 0.25%.

A short but carefully prepared report by Dr. C. B. Dudley, Chemist of the Pennsylvania R. R., reviewed American practice and experiments, and we summarize some of its principal features.

Lighting.—Candles and oil lamps are disappearing. The carburetter system, in which gas is formed by passing air from the air-brake system through material saturated with 88° gasoline, is valuable for use on branch lines where compressed gas is not readily available, and is also used on a few of the more important roads, as it enables equipment to be massed when necessary, as in handling crowds at a terminal where the facilities for charging with compressed gas are not sufficient for such a concentration of equipment. Charging is not required oftener than once in ten days. The use of compressed coal gas is disappearing, although the use of Welsbach mantles may lead to an increase in this system. There is a general tendency toward a much larger use of compressed oil gas, and over 25,000 cars in this country are now equipped with this system. The use of electricity has not made very rapid progress, but the system of having each car fitted with a dynamo driven from one of the axles is worthy of note. Some of the acetylene gas systems have prospect of success, but, "in view of the uncertainties connected with the generation of acetylene, it hardly seems advisable for railways to undertake its generation and compression."

Heating.—The use of steam from the locomotive is the principal system, the feature most worthy of note being the universal abandonment of the two-pipe system in favor of the one-pipe system. Uniformity in couplers and size of pipe is very desirable for proper interchange of cars, and automatic couplers for hose are in use to some extent. Attempts at automatic regulation of temperature have not yet been successful. The Baker heater system is largely used for sleeping cars, the coils being heated by jackets supplied from the train steam pipe.

Ventilation.—This section of the report dealt mainly with the system of ventilation now in experimental service on the Pennsylvania R. R., and recently described in our columns. Fresh air is taken in by a hood in the roof, and led to a conduit under each side of the car, from which it enters the car (passing over the heater pipes; the foul heated air is drawn off by roof ventilators. About 200 cars are now equipped.

In the discussion, Mr. Max Toltz described the Toltz-Lipschutz compressed acetylene system, now in use on the Chicago Great Western Ry. and the Canadian Pacific Ry. Mr. Fowler (Canadian Pacific Ry.) said he had 36 cars equipped with this system, which is very satisfactory; the trouble of charging the tanks is no greater than with the Pintsch compressed oil-gas system. Mr. Martinet, of the Netherlands State Railways, and Mr. Sarre, of the German Government Railway Department, both stated that they had used acetylene mixed with gas, but had abandoned it in consequence of serious explosions. Mr. Verlant stated that the Paris, Lyons & Mediterranean Ry. is now using this mixed gas, but considers that it will be better to use gas with incandescent mantles (as is done on the Eastern Ry. of France), and to discontinue the acetylene. Several speakers referred to the satisfactory use of electricity (generally with a dynamo to each car) in England, Germany, France, India, etc.; in India the avoidance of heat by this system is a great advantage, and 95% of the cars now use this system, replacing gas.

In regard to heating, the direct steam system has the objection that it is difficult to regulate the temperature. Mr. Brisse, of the Eastern Ry. of France, described the Lancrenon system, in which a mixture of steam and compressed air is used. This has been described in Engineering News. Mr. Mitchell (Lehigh Valley R. R.) referred to the adoption of a 2-in. main steam pipe by the American Master Car Builders' Association; these pipes are sometimes fitted with reducers, so as to permit of coupling to 1¼-in. pipes. Mr. Fowler said that the use of 2-in. pipes and couplings enabled the Canadian Pacific Ry. to keep its cars comfortable when the outside temperature is 60° below zero. Mr. Clark, of the Buffalo & Susquehanna Ry., referred to the use of exhaust steam from the engine for car heating.

At the close of the discussion, the following conclusions were adopted:

1. There is a development in the use of incandescent mantles, heated by oil gas and sometimes by common gas, and of different systems of electric lighting. Cylindrical mantles seems to be somewhat stronger than globe mantles, but the latter distribute the light somewhat better. Various types of mantles are used in Europe by different managements, especially in France and Germany, and are beginning to extend to the United States.

2. Systems of electric lighting are giving satisfaction on different roads. Attention is called to their advantage in certain cases for intermittent lighting, in passing through tunnels and operating fans.

3. Acetylene gas has been used mixed with Pintsch gas, especially in France and Germany, but a tendency is observed to abandon this mixture, owing to the use of mantles. On the other hand, mention is made of the use in America of pure compressed acetylene, with some special precautions.

4. Steam heating has a tendency to extend in different countries. To obtain sufficient heat for very long trains, or in cases of very low temperature, care is taken either to use pipes of sufficient diameter or compressed air mixed with steam. The adoption of a uniform coupling for all the cars in the same territory is an important question.

Pooling Locomotives.

The paper by Mr. G. W. Rholes, Assistant General Superintendent of the Burlington & Missouri River Ry., reviewed the history of the pooling system in this country since its introduction in 1875, and quoted a number of favorable opinions. Of 84 lines replying to recent enquiries, 36 were favorable to pooling, and these were in the thickly settled part of the country; while the 48 which do not pool engines (or only in case of an unusual rush of business) are mainly in the thinly settled part of the country. Mr. Boell, Locomotive and Car Superintendent of the French State Railways, reported for 11 countries in Europe and South America, and showed that of 21,900 locomotives there are, on the average, 17,500 in daily use, and 79% of this are worked on the single crew system. But various combinations (double crews, three men to a crew, auxiliary crews, etc.) are adopted permanently or temporarily in many cases, in order to utilize the engines to better advantage. This becomes the more necessary as the men's working hours tend to be reduced. Only one railway (the St. Gothard Ry.) uses the complete pooling system (with no definite crew to any given engine) permanently and exclusively. He considered the compromise systems above mentioned as preferable to pooling. The report by the late Mr. Hubert, of the Belgian State Railway Administration, was presented by Mr. Hodelge. It covered railways in Great Britain, India, and Europe, and showed that complete pooling is but little used, although some of the compromise methods above noted are used. For 12,576 locomotives on 20 railways the methods in use are as follows: Single crew, 8,249; double crew, 3,391; treble crew, 100; multiple crew, 659; mixed systems, 28; complete pooling, 149.

In the discussion, Mr. A. W. Gibbs stated that the Pennsylvania R. R. has used the pooling system for 28 years, except for some passenger trains which have single or double crews. Mr. Drummond, of the London & Southwestern Ry., adopts pooling in suburban service. Mr. Hoy, of the Central South African Railways, uses the "caboose system," with double crews; the crews have 12-hour shifts, and get 10 hours' rest after about 500 miles' run. Mr. Small, of the Southern Pacific Ry., and Mr. Lovell, of the Atchison, Topeka & Santa Fe Ry., have both found it necessary to go back to the single crew system with engines using oil fuel, as these engines require more time in the roundhouse. The following conclusions were adopted:

In Europe and in countries other than North America the general sentiment is very much in favor of the single-crew system and unfavorable to complete pooling, which is only used when necessitated by a sudden increase in traffic. However, for certain services various combinations of double or multiple crews or of mixed crews are used according to circumstances.

In North America, on the contrary, pooling is very general, though little used for passenger service, and a tendency to using single crews is generally manifested. It is, however, in place to remark that the organization of train service depends to a large extent on local conditions.

Automatic Couplers.

The paper by Mr. A. W. Gibbs, Genera[l] intendent of Motive Power of the Penn[sylvania] R. R., reviewed the history and develop[ment] the M. C. B. coupler, and its recent impro[vements]. The failures due to the fracture of the d[raft] or its pulling out of the draft gear, whi[ch] time promised to become serious, have [been] with the general improvement in the str[ength] the coupler and its attachments, and is [now] of great consequence. At to the effect of t[he] duction of the M. C. B. coupler upon the of employees, the following information wa[s] on a diagram presented by Mr. Gibbs:

	1889	
No. of freight cars	1,089,596	
No. equipped with M. C. B. couplers	80,516	
No. of men kill. & inj. in coupling	7,067	

The maximum and minimum numbers [of men] killed and injured were 11,710 in 1893 and [7,067] in 1901.

A report by Mr. G. Noltein, of the Mos[cow] & Kazan Ry., described conditions in Europe. [Only] a few railways have given the subject any [attention], and the German Railway Union has [ap]pointed a committee to examine and test [dif]ferent designs, but only one railway (the Moscow & Kazan Ry., Russia) has applied such couplers in regular practice. Many of the designs are adaptations of the M. C. B. type to European conditions, and it is one of these which has been adopted by Mr. Noltein. A third report, by Mr. W. F. Pettigrew, Locomotive and Car Superintendent of the Furness Ry., described conditions in England. In 1899, a bill was introduced to empower the Board of Trade to enforce the use of automatic couplers, but it was withdrawn. At present four railways have 225 passenger cars equipped with Gould and Buckeye couplers of the modified M. C. B. type, and some narrow gage lines in India and Africa, etc., use a combination spring buffer and coupler.

These reports led to an extended discussion, mainly in regard to European conditions and experiments; improvements in couplers are being considered, partly to prevent accidents and partly from the necessity of strengthening the entire draft gear as the weights of cars increase. The experiments so far made, however, are on too small a scale to be conclusive. Mr. Asselin said that on the Northern Ry. of France only 4% of the accidents to employees are due to coupling and uncoupling cars, and he thought the transition period during the application of a new style of couplings would show a great increase in accidents of this kind. Mr. Gibbs and Mr. Muhifeld referred to defects and improvements in the American or M. C. B. coupler, and Col. Yorke, of the Railway Department of the English Board of Trade, said that men still have to go between the cars to couple up brake pipes. Mr. McIntosh, Superintendent of Motive Power of the Central R. R. of New Jersey, explained that there is already a limited use of automatic couplers for brake and steam heating pipes in this country. The following conclusions were adopted:

The Congress recognizes the universal use of automatic car couplers in the United States, Canada and Mexico. While the type (M. C. B.) remains the same as first adopted, the details have been continually improved. Devices for automatically coupling the air brakes, air signal and steam heat pipes are used to some extent; they are only in the experimental state.

In countries other than those mentioned above several systems of automatic car couplers, either of the American (M. C. B.) type or other types, have been tried. The necessity of working with couplers of a different type from those in use causes great difficulty during the transition stage.

Several representatives were in favor of the American (M. C. B.) type on account of its great strength, especially where large cars are used, while other representatives favored the use of such types of couplers as could be more readily applied to existing stock, so as to reduce the period of transition. The British representatives expressed the opinion that the system used in Great Britain and Ireland is at present satisfactory as regards rapidity of handling, as well as the safety of the employees.

Electric Traction.

The report by Mr. W. D. Young, Electrical Engineer of the Baltimore & Ohio Ry., described the single-phase alternating current motor system developed by the General Electric Co., and installed on the Ballston extension of th[e]

...nectady Electric Ry., and gave in tabular ... the replies of eight railways to a series of ... questions as to their electric traction systems. ... include the four miles of third-rail system ... the main line of the Baltimore & Ohio R. R. ...altimore, and certain parts of the New York, ... Haven & Hartford Ry. The others are ...ley lines, but five out of the eight lines use ...m and electric traction on the same tracks. ...ngthy report by Mr. Ernest Gerard, Inspector-...eral of the Belgian Railway Administration, ...t mainly with the "electrification" or change ...n steam to electric traction on two of the Lon... underground railways, the Mersey Tunnel ... at Liverpool, and on suburban lines of the ...rtheastern Ry. and the Lancashire & York...hire Ry. The results in all these cases have ...been an increase in the number and speed of ...rains, the number of passengers, and the re...eipts, with a material decrease in the cost of ...peration. Two other reports, by Mr. Paul Du...bois, Engineer of Locomotives and Rolling Stock ... the Paris & Orleans Ry., and Mr. Victor Tre...montani, Manager of the Electrical Department ... the Mediterraneon Ry. (Italy), dealt with the general aspects of the question rather than its application to individual cases. Both concluded that electric traction is to be regarded as a useful auxiliary to steam traction for certain classes of railway traffic.

In the discussion, Mr. Schulz gave some particulars of the experiments with high-speed electric traction in Germany. Speeds as high as 124 miles an hour were attained, the train resistance at this speed being 660 lbs. per ton; the car could be stopped in 3,280 ft. Mr. Aspinall gave further particulars of the service on the Lancashire & Yorkshire Ry. (England), where three classes of passengers are carried. With trains of four or five cars the crews are a motorman and conductor for fast trains and a motorman with two conductors for local trains. The station stops average 15 seconds. Mr. Laurent described the electric handling of regular trains on the Paris terminal line of the Paris & Orleans Ry., which has been described in our columns, but in regard to the German experiments he pointed out that these excessive speeds are only attained by an enormous increase in the power consumption which involves great expense. The following conclusions were adopted:

Electric traction should be considered at present as an important auxiliary of steam traction, being capable of handling certain portions of railway traffic with advantage and economy.

It is impossible in a general conclusion to point out the exact service to which electricity can be most readily applied, the application being essentially a question of local conditions, each particular case requiring special study. In this study there must be taken into account the expense of electrification and the following points: 1. Condition of service—that is, (the frequency and weight of trains); 2, the physical conditions of the line, such as length, profile and plan. In comparing the expenses of operation by electricity and by steam, the interest and depreciation on the electrical installation must be considered.

The increase in revenue which the improvements in service will generally produce should also be given consideration. An important point in the use of electricity is the increase in the present station facilities resulting from the reduced number of movements in the stations by the use of electric traction.

From the information furnished it would seem that with the third rail as now used, security can be assured under favorable conditions without its being necessary to cover or protect the third rail for its entire length.

The Congress has heard with much interest the results experienced with high-speed electric traction on the line between Marienfeld and Zossen, and also of the tests and first applications for traction purposes of the alternating monophase motors in several countries.

The Congress recommends that (on account of their future usefulness) exact data on the cost of electric traction be obtained.

SECTION 3.—OPERATION.

Baggage and Express Parcels.

The two papers covering these subjects were by American railway men: Mr. George H. Daniels, General Passenger Agent of the New York Central Ry., dealt with the first; and Mr. J. J. H. Bradley, General Traffic Manager of the American Express Co., dealt with the latter. There was a brisk discussion as to the respective merits of the European and American systems of handling baggage, and the latter certainly came out rather second-best. There seems to be much quicker handling of baggage abroad, and also much less damage done, while the cheap cab fares enable passengers to readily take their baggage with them to and from the trains. In Austria, where both systems have been tried, the English plan, without checking and without receipts, is preferred. In France, baggage is not checked, but receipts are given to passengers, and the railways are encouraging a private baggage transfer company. The following conclusion was adopted:

After hearing a large number of reports on methods pursued in America, Europe and other countries throughout the world, for the transportation and protection of baggage and express parcels, it is the opinion of the Congress that the arrangements at present adopted by the different countries best meet their varied requirements, and there are no grounds for recommending any particular system.

Suburban Traffic.

Practice in foreign countries was dealt with in a paper by Mr. H. G. Drury, Superintendent of the Line, Great Eastern Ry., England. It pointed out that the characteristic feature of this service is the necessity of handling a very heavy traffic concentrated into a very short period of time every morning and evening. While heavy traffic might at first seem to be remunerative, yet as a matter of fact the revenue is so small (due largely to government restrictions) as compared with the expensive works required and the interference with general traffic, that "it is a question whether it is fair to impose upon the shareholders of private companies the responsibility of meeting obligations which arise out of the general needs of a community." At the London terminal station of this railway about 86,000 passengers arrive daily, with 200 to 384 trains per hour, the maximum number of trains arriving being between 9 and 10 a. m. The average speed of suburban trains is 19½ miles an hour, with 28-second stops at stations. In order to distribute the traffic as much as possible, the first morning hours are divided into "time zones" for the districts inhabited by the working classes, the fares varying with the time at which passengers take the train.

An excellent paper dealing with suburban traffic methods and equipment under American conditions was presented by Mr. A. W. Sullivan, General Manager of the Missouri Pacific Ry. The discussion opened with the subject of the introduction of electric traction in the suburban service of steam railways. Mr. A. Wilson, Assistant General Manager of the Northeastern Ry. (England), stated that his road has been operating for the past year an electric suburban service at Newcastle with the object of regaining the traffic from the competing electric street railways. Not all the traffic has been regained, but the amount handled has been considerably increased. The reduction in expenses has resulted in a net revenue which more than covers the interest on the extra cost of installation necessitated by the introduction of the electric power. The current is furnished at a reasonable price by power stations which do not belong to the railway. Mr. A. Mange stated that the Paris-Orleans Ry. operates electrically 12.4 miles on the Paris-Juvisy line, with 100 trains daily instead of 75 as before the use of electric power. Four tracks are used, two for express tracks and two for locals. Trains are operated with motor cars at each end. There are two types of trains: heavy trains, 286 tons and 1,000 seats; light trains, 73 tons and 650 seats. the labor of one man on each train is saved. This system has been described in Engineering News.

Mr. Sullivan stated that at the South terminal station at Boston there is a separate loop terminal for suburban service. Reversible motor trains like those of the Paris-Orleans Ry. reduce considerably the time required at the terminal between the arrival and the departure of the trains. But the loop arrangement insures a still more complete continuity and avoids the inconveniences due to switching from one track to another.

As to the types of cars best suited to suburban service, Mr. Jenny, Superintendent of the Southern Ry., of Austria, has experimented in the suburban traffic of Vienna and has observed that cars provided with doors at both ends for the incoming and outgoing passengers give the better results; the cars were emptied and filled in 30 to 40 seconds. Mr. Sullivan, on the contrary, prefers side doors. The latter system has enabled the Illinois Central Ry. to accomplish the same operation in ten seconds, with a train carrying 1,000 passengers, and to send out on the same track five such trains in four minutes. These cars are of special design, with cross seats leaving an inside gangway along each side of the car, so that passengers can find seats after the train has started. These cars have been described and illustrated in Engineering News. So rapid is the operation with cars of this type, that 100 passengers have been discharged from a car at a terminal station in four seconds; and ordinary stops at intermediate stations where many passengers enter and leave the trains are made in six to eight seconds. The following conclusions were adopted:

To be in the highest degree remunerative, the traffic must be handled rapidly, by simple and inexpensive methods, and with the minimum working organization necessary for the purpose. The type of car is the essential factor; new lines to be constructed should be adapted to the best types of cars. On old lines, in order to utilize to the utmost the space between tracks, the cars should be as wide as possible.

The locomotives should be sufficiently powerful to haul trains of maximum size at the speeds required. The train schedules should provide for the movement of all trains at a uniform speed and stopping at all stations upon the same tracks. Separate tracks should be provided upon lines of heavy traffic for trains which are run at high speed and do not stop at all stations.

All necessary measures should be taken to accelerate the movement of passengers and start the trains promptly. In this way the expenditure of energy required to regain time lost is conserved, and the promptness with which the service is conducted communicates itself to the passengers, who quickly learn to move more rapidly.

The frequency of train movements should be proportioned to the volume of traffic, to avoid prolonged waiting of passengers and congestion at stations.

The Congress has listened with interest to the description given of the use of electric traction in England and France, but it is not in a position to express a preference for one or the other method of traction, steam or electricity.

The Automatic Block System.

American practice in automatic block signaling was dealt with in a report by Mr. C. H. Platt, formerly General Superintendent of the New York, New Haven & Hartford Ry., while foreign practice was covered in a second report by Mr. Margot, Assistant Engineer of the Paris, Lyons & Mediterranean Ry. Mr. Platt dealt especially with the latest improvements, including the Hall Signal Co.'s motor mechanism and electro-gas mechanism, in which latter the power is developed from liquefied carbonic acid gas; the company has also introduced a semaphore blade which is pivoted at the center and continually revolves for the "clear" indication (giving a flash light), but is stationary for the "stop" indication. As to the three-position signal, it has an advantage in reducing the number of arms to be observed by the enginemen, and is well adapted to local conditions on many lines, but has not met with general approval. The improvements introduced by the Union Switch & Signal Co. include the following: 1, Polarized rail circuit system for the elimination of live wire on steam and electric railways which do not use the running rail for the power current; 2, alternating current track circuit control for railways which use the running rails for power current; 3, Direct-current track circuit control with auxiliary polarized feature for railways which use the running rails for power current; 4, the electric semaphore, with motor on the post; 5, Block signalling for electric railways, as used on the New York subway. The Pneumatic Signal Co. has also an electric automatic block system for electric railways, utilizing the running rails for the return current. The Miller Signal Co.'s automatic electric signal, displayed in the engine cab, was also described. The block signals in use were tabulated, but only up to September, 1903; we condense this statement as follows:

	No. of railways.	No. of signals.	No. of miles of track.	No. of isolated signals.
Elect.-pneum. semaphore	9	3,100	917.6	..
Electric semaphore	20	3,950	2,654.2	99
Electro-gas semaphore	9	490	226.4	5
Enclosed Disk	30	4,312	2,724.9	173
Clockwork Disk	7	952	779.3	138
Total	75	12,804	7,802.3	415

1. Including haul (8,205) and distant (4,599).

2. On single track basis (2,878.7 miles of two or more tracks).

3. For protecting drawbridges, junctions, switches, etc.

As to the efficiency, there was only one unnecessary stop for every 10,050 movements and one false "clear" indication to 541,637 movements. During 1904 the number of movements increased 144%, but the number of cases where signals indicated "stop" when the sections were clear increased only 32%, while the more serious failures of signal indicating "clear" when the sections were occupied actually decreased 30%.

The report by Mr. Margot showed that in Europe there are only five installations aggregating 100 miles: Southern Ry. (France), 26 miles; Paris, Lyons & Mediterranean Ry. (France), 49.5 miles of Hall system; Austrian Southern Ry., 8.7 miles; London & Southwestern Ry. (England), 5.6 miles; and Northeastern Ry. (England), 9.9 miles. In France, the number of failures is said to be 28 to 80 per 100,000 movements, as against 3 to 6 on railways using non-automatic block systems. These results are largely due, however, to the limited extent and experimental character of the automatic signal installations.

In the discussion, Mr. Riche, of the Eastern Ry. of France, remarked that it was a question of the ratio between human error and mechanical failures; he thought that an increase in number of trains without decrease in safety of operation could be more readily secured by the use of automatic than by manual apparatus. Mr. Voorhees said that 15 years ago he installed the manual block system on the New York Central Ry., with 102 block stations to 142 miles of line, but the traffic became so dense that it had to be operated permissively. On the Philadelphia & Reading Ry., all parts having dense traffic (400 miles out of 1,400 miles) are now equipped with automatic signals, and there is no difficulty in handling the traffic. Sir Charles Owen stated that the London & Southwestern Ry. is applying mechanical operation to non-automatic signals, but that for dense traffic the automatic system is preferable; his road equips each signal post with a telephone. Mr. Bleynie said that the Southern Ry. (France) had a large number of failures of automatic signals, many of which are due to the overhead wires fouling other wires, but Mr. Platt explained that overhead wires have been practically abandoned in this country.

The conclusions adopted were as follows:

Automatic signaling properly designed and installed is recognized as a suitable means of protecting train and switching movements. There has been much improvement and extension of automatic signaling since 1900, and those who have used it have found it effective for their purpose. The Congress is not prepared to recommend automatic block signaling for general adoption to supersede existing systems, but considers that there are cases where this system may present special advantages.

SECTION 4.—GENERAL.

Slow Freight Rates.

There were four papers on this subject, including one on American practice by Mr. M. C. Markham, Assistant Traffic Manager of the Illinois Central Ry. Mr. Lewis Wood described the organization and methods of operation of the British Railway Clearing-House. Mr. Dring (East Indian Ry.) described the practice in India, where the railways are owned and operated by the government and by companies; in order to secure returns on the investment, the government has established both minimum and maximum rates. The representatives of Australian government railways stated that the same conditions prevail in Australia, the government furnishing the capital and requiring a revenue of 3½%. Mr. Mange, of the Paris & Orleans Ry. (France), thought that the rate should be between the commercial value of the service (as a maximum) and the actual cost of transportation (as a minimum). The subject was discussed at considerable length, and the following conclusions were adopted:

Tariffs should be based on commercial principles, taking into account the special conditions which bear upon the commercial value of the services rendered. With the reservation that rates shall be charged without arbitrary discrimination to all shippers alike under like conditions, the making of rates should, as far as possible, have all the elasticity necessary to permit the development of the traffic and to produce the greatest results to the public and to the railroads themselves.

ACCOUNTING.—There were three papers on this subject, and after some discussion a series of conclusions was adopted, in which reference was made to the importance of simplicity and uniformity, as well as the advantages of such modern devices as typewriters, calculating machines, etc.

DURATION AND REGULATION OF WORK.—The three reports on this subject described the arrangement of working hours, rates of pay, etc., for railway employees in various countries, and the paper by Mr. G. L. Potter (Third Vice-President of the Baltimore & Ohio Ry.) also summarized the various State laws regulating labor conditions. The conclusions adopted set forth the impossibility of establishing uniform rules, and the desirability of the employer having power (under control of suitable authorities) to fix the rules and regulations for employees.

PROVIDENT INSTITUTIONS.—The subject of the reports embraced general principles of methods for the retirement, insurance and pensioning of railway employees and workmen. A very long report was submitted by Mr. M. Riebenack, Assistant Controller of the Pennsylvania R. R., and related to all English-speaking countries. It showed a great variety of methods of caring for the well-being of employees, including not only pensions and insurance, but also the provision of libraries, hospitals, etc., and Mr. Riebenack considered that the very important was the combination of means of providing for sick, injured and aged employees (also death benefits), and also providing for the mental, physical and spiritual betterment of men in good health and engaged in regular occupations. A report relating to countries not speaking the English language was made by Mr. M. Lemercier, Secretary of the Eastern Ry., of France. In Germany, Switzerland and Austria there are laws for compulsory insurance of workmen. The report described the practice of various countries and also discussed the principles of insurance, pensioning, etc.

SECTION 5.—LIGHT RAILWAYS.

The Relation of Light Railways to Main Lines.

This report was prepared by Mr. D. Burlet, General Manager of the Belgian National Light Railways Society, but in his absence it was presented by Mr. Lembourg, of the same company. The report was based upon replies to enquiries sent to the officers of main lines in various countries, and was therefore necessarily somewhat inconclusive, owing to the lack of uniformity in the methods of keeping accounts of the interchange traffic. The general character of the returns, however, indicate that light railways have a very beneficial effect upon the main lines to which they are tributary, and the Southern Ry. of France, estimates that the former increase the traffic of the latter at the junction points by about 50%. There are exceptions in certain cases where the light railways practically parallel the main lines and become competitors rather than feeders. The Italian railways have also objected to the competition of the steam tramways built along the country roads, but these are more properly suburban lines, and Mr. de Burlet is of opinion that this suburban traffic is a burden rather than a benefit to the main lines. Co-operation with trunk lines, either for the construction or operation of light railways, appears to have been rather the exception everywhere up to the present time, except in cases where the trunk line is operated by the government, which, however, is tending to become the general rule in continental Europe. Most frequently when the operation of the light railway is kept separate, this co-operation with the main line is confined to the granting of facilities for the establishment of transfer stations and the service of the latter.

In opening the discussion, Mr. W. M. Acworth, representing the railway department of the Board of Trade (England), said that in England the main lines will afford no facilities for light railways or assist in any of the expense [illegible] junctions, with the result that light rail[ways] are rarely built. Mr. Weissenbruch (M[inister] Railways, Belgium) thought there would [be] use for industrial light railways in A[ntwerp] connect factories, etc., with main lines [which] tories are generally located directly [on] latter. Mr. Scialoja (Sicilian Railways) that the Italian government has passed making very liberal regulations for co[n]ditions between light and main lines. The gov[ernment] will also assume possession on July 1 of main lines now owned by private compan[ies] will probably assist in the development [of] and secondary railways. Mr. Von Leb[en] trian State Railways) thought that experi[ence] indicated that it is to the interest of [the] lines to assist in the development of [light] ways.

As a result of the discussion, the following conclusion was adopted:

It may be said in general that light railways, [when] they are really tributary to main lines, are unquestionably useful auxiliaries to the latter. Consequently the friendly cooperation of the main lines and concessionaires of the latter of desirable facilities are fully justified. It is to be desired that all railway managements should be inspired by the liberal ideas held on this subject in Austro-Hungary, and adopt as broad and simple conditions as possible to facilitate junctions and the operation of interchange of traffic with light railways.

Government Aid for Light Railways.

There were two reports on this subject, covering assistance not only by the general government but also by counties, districts, etc. One was by Mr. Colson, of France, and the other by Mr. Ziffer, of the Lemberg, Czernowitz & Jassy Ry. (Austria.) Mr. Colson's paper pointed out that rural railways are rarely capable of earning a revenue proportionate to the capital expenditure, and consequently subsidies to private companies are necessary to secure the construction of such lines for the public benefit. This sometimes involves complications, as even where the main railways are operated by the government it is recognized that light railways should be in the hands of private companies. The paper discussed the methods of determining the amounts of subsidies, and gave an abstract of the legislation relating to light railways in various countries of Europe. The paper by Mr. Ziffer gave similar information in regard to countries not covered by the first report. In the brief discussion which followed Mr. Franke, of the Prussian State Railways, described the methods of assisting light railways adopted by the Prussian government, and Mr. Cooper, of the Glasgow Southwestern Ry., stated that in Scotland there are about 120 miles of light railway; these have been generally built without any government assistance, and one of them (24 miles long) cost $50,000 a mile, and is operated by a steam motor car capable of hauling two trail cars. The following conclusions were adopted:

Light railways merit in the highest degree the attention of public authorities. Their construction makes it possible to encourage the progress and development of districts which previously have remained in the background, and it is accordingly not only the interest but the duty of the governments to assist them. It is desirable, therefore, not to adhere to old types and old methods of construction, operation and regulation, but to introduce every facility possible, adaptable to local needs and available resources. It is also desirable that state governments and local authorities should accord to light railways, either under the form of subsidies, relaxation of requirements or other methods of assistance, the support which they need, both for construction and for operation, so that all parts of the country may be adequately served. When the authorities of a country do not themselves construct or work light railways, and turn them over to private companies, it is indispensable that the terms of the concession should be so defined as to harmonize the interests of the working company with those of the public.

Cheap Service on Branch Lines and Light Railways.

The reports by Mr. Rocca, of the Mediterranean Ry. (Italy), and Mr. Tolnay, of the Hungarian State Railways, pointed out the economies and advantages to be derived from special facilities for local traffic, with light trains and a minimum number of employees, etc. The use of motor cars for such traffic was also mentioned. The value of the return current of electric railways is increasing—the adhesion of the wheels was referred

but the experiments have not produced definite or reliable results. The following conclusions were adopted:

The simplification of the service on lines which carry little traffic is of general interest to all railways operating such lines. The Congress expresses the wish that the present tendency of legislation to establish more liberal regulations for lines with little traffic and light trains may become more general, and that the efforts of the managements to equip their light traffic lines with a more economical organization, which promise to give remarkable results, be continued. The simplifications introduced in the maintenance of way, stations and trains, as well as the introduction of automotor cars on different lines, merit recommendation.

While recognizing that the technical side of the question of automotors, as applied up to the present time, are capable of improvement, the Congress expresses the opinion that experiments with this method of transportation should be continued.

Traffic Conveyed by Motor Cars.

This report was prepared by Mr. Felix Sartiaux, Assistant in the Traffic Department of the Northern Ry., of France, but under the direction of Mr. E. Sartiaux, Chief Electrician; Mr. Lechelle, Traffic Manager, and Mr. Keromnes, Chief Engineer of the La Chapelle shops, all of the same railway. The report presented information respecting a number of railways, and much of this has already been given in different articles in our columns. In addition to motor cars on railways, the report also referred to the use of automobiles on public roads, operated by railways as feeders to their lines. A motor car service is considered as advantageous in two ways: 1, On secondary lines where the number of passengers is small, or where it is desired to increase the traffic; 2, On main lines, to accommodate a suburban or local traffic insufficient for even light trains, or to supplement the regular train service between certain points. Steam cars are powerful and economical, but have not a rapid acceleration; oil-engine cars have excessive vibration, but the cost of maintenance is very low; storage battery cars have limited power and excessive dead weight.

Mr. Laurent said that in 1903 the Paris & Orleans Ry. introduced a 20-ton steam car, which can haul two small trail cars. He is now building 10 similar cars, of about 200 HP., with one end carried by the motor truck and the other end by a trailing axle. Chain driving gear is used. These cars will be used to replace trains on lines of light traffic, to give increased service on main lines, and also to provide local service on main lines, by which the number of stops of through trains may be reduced. Mr. Delannoy said that Western Ry. of Flanders has used steam cars (with locomotive boilers) for 10 years, and they were shown to be used for economic reasons on railways in the thinly populated districts of Africa and Australia. The following conclusions were adopted:

1. Experiments with motor cars and with automotors hauling trailers have been numerous during the last few years to an important extent, both for use on lines with little traffic and for use on busy lines, and it may be expected that these cars will constitute a valuable means of transportation, which on some lines will have a great future.

Owing to the saving in an employee in driving, to the material reduction in the cost of traction, to the probable reduction in the cost of maintenance, to a better utilization of the rolling stock, to the smaller extent of station installations required, perhaps also owing to less wear of the rails, there is no doubt that automobile and automotor cars will make it possible to materially reduce the cost of working lines with little traffic, and will in the cases of other lines result in a material improvement in the working of some classes of service. Their use will certainly effect a change in the system of operation in the case of a great number of lines and appears to have a real future before it. The period of actual operation has, however, only just begun and definite economic results cannot yet be clearly discerned in favor of a given type of motor or of a given system of working.

2. It is desirable that railway managements should continue their experiments in this direction and more especially investigate the classes of service to which this new motor is suitable, and the advantages it offers the public and the railway managements, particularly in the matter of cost.

3. Finally it is important that any changes recognized or which may be hereafter recognized, as likely to facilitate the advantageous use of automobile and automotor cars should be introduced into the regulations in force.

On the last three days of the Congress general meetings were held, at which the conclusions adopted by the several sections were considered and (after amendment in some cases) formally adopted as the conclusions of the Congress.

At the closing meeting on Saturday afternoon, May 13, Mr. Ramirez (of the Chilian State Railways) moved that the permanent commission of the Congress be requested to include in the program of the next meeting the subject of "Methods of Railway Construction." Mr. Kupka (of the Emperor Ferdinand Northern Ry., of Austria) made a similar motion in regard to "Principles of Railway Statistics." Both of these were adopted. There were 19 new members elected on the Permanent Commission, including Messrs. L. F. Loree, J. Kruttschnitt and T. N. Ely. As it is usual to increase the number of members of the Commission for the country where a meeting of the Congress has been held, the number of American members was increased from five to nine (the maximum). The new members are as follows: Mr. Paul Morton, Mr. G. W. Stevens, Mr. Charles M. Hays and Mr. Frank Barr. This was the first Congress at which Germany was officially represented, and two German members were therefore appointed upon the Commission. It was decided to hold the next meeting in Switzerland in 1910, and the following officers were elected: President, Mr. Dubois; Secretary, Mr. Weissenbruch; Treasurer, Mr. Holemans.

CLOSING ADDRESSES.

The regular business having been disposed of, Mr. Stuyvesant Fish made a closing address on behalf of the American section:

The plan of work and of discussions proposed by the Permanent Commission shows, as usual, infinite patience in its preparation and a thorough knowledge of the subjects best meriting attention, and was worthy of, and received, the best judgment and consideration of the Congress. For what has been accomplished credit is primarily due to the Permanent Commission, sitting in Brussels, for its constant and untiring labors during the five years which have elapsed since the sixth session. Especially is credit due to its president, Monsieur Dubois, who we regret was unable to be with us and to Monsieur Gerard who came in his stead and whom we have all learned to love, honor and respect. Our thanks are also due to Mr. Weissenbruch, the affable and experienced secretary general; to the indefatigable secretary-treasurer of the commission, Mr. Holemans, and to the staff of the secretary general, particularly the chief clerk, Mr. Habran.

The thanks not only of the Congress, but of the whole railway world, are also due to the gentlemen who have taken from the scant leisure given to railroad officers, time enough to prepare the elaborate technical reports which have been so ably and fully discussed in the Congress. To the presidents of the sections, to the vice-presidents who have shared with them the arduous work, and to the principal secretaries and to the secretaries, we are deeply grateful. To their technical knowledge of the various subjects discussed, to their tact in conducting discussions in several languages, with absolute fairness and perfect courtesy; to their experience, patience and skill, it is due that the Congress has achieved what I conceive to be the main aim of its existence—the interchange among the experts of the whole world of the results of sound railway practice based on ripe experience.

Apart from the technical work of the Congress, we have at this session been enabled, through the untiring and uncompensated exertions of Mr. George A. Post and his associates in the exhibit of railway appliances, to show to the world what American inventors and manufacturers have done and are doing to make railway service more efficient, safer and more comfortable and rapid, and, if possible, more economical alike to the companies charged with the operation of railways and to the public served by them.

Those familiar with the history of railways will recall how often in times past and in all countries, experience has repeated itself at a vast outlay of treasure and of human life in making the same costly experiments over and over again to no purpose. Printing has been called the "art preservative of all the arts," and I cannot help thinking that for the future the records of the various sessions of the International Railway Congress will preserve the experience of the past, for constant use in the great work of the railways in welding together the whole human race into a true "brotherhood of man."

Mr. Gerard, Vice-President, in the absence (through illness) of the President, Mr. Dubois, then delivered an address on behalf of the visitors, from which we take the following extracts:

When we read the program before sailing for America, we could already realize the great labor which its preparation had entailed on the American section, in correspondence and arrangements of every description. We had formed a general idea of the kind of reception awaiting us, but I think I am safe in saying, in the name of all you gentlemen present, that what we have seen and the welcome we have met have surpassed all our expectations.

You made no mistake, gentlemen, in entrusting the welfare of the Congress to the able hands of Mr. Stuyvesant Fish. Presided over by him, the meeting has been a fruitful one; all the departments have been handled most admirably, including that of regular reports published in the "Railway Age." The American Railway Association and the American Railway Guild, under the inspiration of its master, Mr. Ely, and—it cannot be repeated too often—the unwearied devotion of Mr. Allen to his multiple duties, and the Washington local committee, under the leadership of Mr. Fairfax Harrison, who arranged such instructive excursions and visits, have merited in countless ways the expression of our gratitude.

And remember that the vast program arranged by our American colleagues is far from being exhausted. The booklet which we have all received, to guide us on the long and short tours of inspection, bears plain witness to the care taken by all the reception committees to arrange for these visits. These preparations and the facilities for transportation that the American railway companies have so bountifully placed at our disposal, assure us that the trips which we are about to take will be on a par with the receptions given in our honor up to this time; thereby rendering the sojourn of the members of the Congress one which has been fully as pleasant as it has been useful and instructive.

On motion of Mr. Heurteau, a special vote of thanks was passed to the members of the American section, to Mr. Fish and Mr. Allen, and to all who have participated in the arrangements for and entertainment of the Congress. Mr. Stuyvesant Fish then formally adjourned the meeting.

THE SOCIAL AND ENTERTAINMENT FEATURES OF THE INTERNATIONAL RAILWAY CONGRESS.

We concluded our report of the International Railway Congress last week with the proceedings on Saturday, May 6. In the preceding article is given a summary of the Sectional Meetings of the Congress for the discussion of technical questions. We present here an account of the social features of the meeting and the entertainment tendered the guests.

Sunday was observed as a day of rest, the Railway Appliance Exhibition being closed and no entertainment being arranged for the visitors, who were very willing to remain quiet after their busy week of sight-seeing and excursions.

On Monday afternoon the sectional meetings adjourned at an early hour, and many of the delegates visited the Exhibition. Others went to the Government Departments, where especial arrangements had been made for their reception. In the evening a large reception was given to the visitors at the German Embassy.

On Tuesday afternoon special trolley cars conveyed the visitors to the site of the new Union Station, where they were received by a delegation of the engineers in charge of the work, and explanation was made of the important engineering features in connection with it.

In the evening a dinner was given by the American Railway Association in the ballroom of the New Willard to about 350 delegates and visitors to the Congress. The dinner was presided over by the President of the Association, Mr. Stuyvesant Fish, who is also President of the Illinois Central R. R. Co. The first of the after-dinner speakers was M. Emile Heurteau, of the Permanent Commission, Director of the Paris & Orleans Ry., of France. He was followed by M. Jusserand, the French Ambassador, and then by Secretary of War Taft. Secretary Taft's speech has attracted attention all over the country by his allusion to the Governmental control over railway rates, and the impromptu discussion which ensued between the Secretary and President Fish. As the opinions expressed in this discussion have been given so much publicity, we print abstracts of these speeches as follows:

Secretary Taft.—I rise with a great deal of hesitation to speak, for the reason that I realize that I am in the presence of the great constructive geniuses of the world. It has been my humble part within the last year to engage in the selection of men to construct, possibly, the greatest work of the century, the Isthmian Canal, and when we looked about for the men who could do the thing we found ourselves largely limited to the railway men of America.

As to the question of railway rates, I have read as far as I could with a good deal of interest the objection to the regulation of railway rates. Some gentlemen are convinced that railway rates are so complicated that nobody ever could regulate them. Theoretically that may be

correct, but practically, gentlemen, there is no power so complicated in its operation, which comes so near the people as railway rates, that the public will not regulate it if there is an abuse. That may not be palatable, but it is true. What the railway men of this country ought to do is to assist in the passage of a law that will accomplish the result. It is not an easy law to draw, but if they will stand up and assist, they will take away from the extreme feeling which exists against the railroads. I am the last one to argue in favor of government ownership—I think nothing could come to this country that would be so unfortunate in its effect as the government ownership of steam railroads. And we are not going to come to it, but we may have a campaign on the subject which will do no good to the railroads.

It is true that the railroads have been guilty of some abuses, and I say this because I have run railroads for ten years in court as a judge through receivers. Ant it was mighty hard sometimes to get receivers who would not cut rates. I had to stand them up at the end of every week and swear them to be sure, and then I was not quite sure that they were not cutting rates.

Most of the railroads of to-day are prosperous, and when they are prosperous they can obey the law; but when it comes to a question of the survival of the fittest, then the weakest begin to break the law and that leads all the others in the same direction. What we want is a law that will enable the railroads that wish to obey the law to compel the others to do so or else go out of business.

I heard the other night a speech from a gentleman whom I very much admire, an old friend of mine, President Baer, and I thought his tone, his attitude toward regulation was one that was likely to lead the railroads into a position from which they must some time sorrowfully retire. The railroads are a public institution—an institution which must be regulated by law. You can not run the railroad as you would run a private business. You must respond to public demands and if there is danger of discrimination, then you must allow the establishment of some tribunal which shall punish that discrimination and give every man who is affected unjustly the right to be heard and the right to a remedy against such discrimination.

Stuyvesant Fish.—The words of the last speaker certainly require something from one in my position.

He said, as I recall it, that the railways are public institutions—so near to the people that it is requisite that there should be control over them in cases of injustice. That sentiment I have no hesitancy in endorsing, not only for the Illinois Central Railroad Company, but, I believe, for the other railroads and every railroad man in the country. The point wherein we may differ he did not state, although he did say that he was opposed to government ownership of railways. But there is a middle ground between the two, to which the Congress of the United States is and has been, very seriously giving its attention. That question is being considered at this moment, day by day, patiently, by a committee of the Senate, which is sitting during the recess. That is the question whether the government shall undertake to fix the price of the goods furnished by the railway companies, which in this country at least are private corporations for gain.

Parenthetically, let me say what I should have said before, that in so far as rebates, tricks, devices, frauds and dishonesty of one kind and another are concerned, the laws are ample. The common law was ample. The present interstate law is ample. The Elkins law of three years ago furnished the specific means of carrying the other laws into effect. These things can be stopped, and should be stopped. The thing we lack to-day is not legislation, but administration. These laws which Congress has passed and the President has approved should be enforced, and be enforced without fear and without favor.

There are two ways of regulating prices. England tried for 500 years by repeated Acts of Parliament to fix the price of bread, to fix the price of wages and to fix the price of all sorts of commodities. About 200 years ago, that method of regulating trade was abandoned and what the political economists call laissez faire was introduced. This consists of giving free play to competition of markets and of ports; that is, the law of supply and demand.

The question to-day, therefore, is whether Congress is to regulate commerce among the states on the idea that it or its deputies can tell 80,000,000 of people what is to be at some future time a fair price for a thing which does not exist at the time the law is enacted—transportaion between several points—or whether Congress is to allow, as it has allowed since the adoption of the constitution, absolute free trade among the several states. If we are to progress—I believe we must have absolute free trade among the several states, without any trammels being put by the regulation of commerce through the fixing of the price of commodities or of services, and railway freights are commodities or services.

Secretary Taft.—I did not expect to get into an intricate discussion on the subject of rates. The law, as has been decided by the Supreme Court of the United States, is that first a commission and then the courts may decide whether a particular rate is reasonable or unreasonable. It has been also ruled that such is the common law. In the mental process of determining whether a rate is reasonable or unreasonable, you have got to fix in your own mind what is a maximum rate. As I understand it, what is proposed only is that in litigated cases a commission shall be constituted that shall fix a maximum rate. In other words, the commission shall go through the same process that it now goes through to fix what is unreasonable and simply say that for a certain time that shall be the maximum rate. It seems to me that the step proposed actually and practically, is comparatively slight.

What I am strongly in favor of, though, is that we shall have a body that shall finally decide things within a reasonable time.

I am not a railroad man, but I have come into contact with railroad litigation and know something about the interstate commerce litigation. I know you began a case four years ago over an issue as to whether a particular town was prejudiced or not as to the way in which the rates were made for that town, and five years hence the case is decided by the courts, and in the meantime the town has been wiped out by a tornado.

What you need is an efficient law to accomplish what we all agree ought to be accomplished. I agree that if it were possible for the law of supply and demand to regulate rates it would be better to leave it to that, but it is because that has been found not to work that some other course has been demanded and I appeal to the railroad men to think over the question whether, even though they may be able to block legislation now and again, it is not wiser to compromise our theories on the law of supply and demand and get down to a basis in which there shall be not only a compromise, but there shall also be satisfaction and peace, both for the people on the one hand and the investor on the other; for that it what we seek, both of us—justice.

Mr. Fish.—In speaking I was so thoroughly imbued with the idea that under the common law and under the present law there is ample machinery for preventing anything like extortion or excessive rates per se, that I did not mention that aspect of the subject. I am willing to give anything, to yield anything, that the extremest man might demand on that score. Nor did I suppose that there was any suggestion that rates in the United States anywhere were in or of themselves excessive or extortionate. Therefore I did not mention that. I think we are all perfectly agreed that there is (and if there is not there should be) power under the law to prevent for all time and in all places excessive and unjust rates. It is merely the question of the liberty of fixing the seller's price of his goods that I am contending for. Provided that his price be reasonable, the railroad is entitled to this.

The other speakers at the dinner were Jean Kologrivaff, of Russia; M. Metzik, of Hungary, and M. Ernest Gerard, of Belgium.

On Wednesday afternoon, after the conclusion of the sectional meetings, a party of the delegates visited the Washington Navy Yard and gun shop. In the evening a reception was tendered the delegates by Mr. and Mrs. Geo. Westinghouse at their residence on Dupont Circle.

On Thursday afternoon excursions were made to the Patent Office, the Pension Office, and the National Museum, and in the evening a second dinner was given by the American Railway Association. Mr. Fish again presided; but there was no such unpremeditated and earnest discussion by the principal speakers as that which made the dinner of Tuesday notable. The post-prandial exercises were opened by the reading of a cablegram from the Emperor of Germany as follows:

I send my greetings to the International Railroad Congress in which for the first time German delegates are participating. May the personal exchange of ideas among the most prominent railroad men in the world, assembled in Washington, be of lasting benefit to international traffic, the prosperous development of which is the most effective way of fostering mutual understanding and the bringing together of nations in peace.

William I. R.

The speakers of the evening were Sir Geo. Armytage, President of the Lancashire & Yorkshire Ry. of Great Britain; the German Ambassador, Baron Speck von Sternberg; Postmaster-General Cortelyou, and Mr. J. N. Baldwin, of the Legal Department of the Union Pacific Ry. Mr. Cortelyou's remarks referred particularly to the relations between the Post Office Department and the railways. Mr. Baldwin is a speaker of unusual force and power, and he devoted himself chiefly to opposing Government interference with railway rates.

Following this came addresses by Jean Kologrivaff, of Russia, in which he took occasion to pay a handsome compliment to Mr. W. F. Allen, Secretary of the American Railway Association. The last speaker was Mr. Sierra, delegate of the Chilian Government.

It had been hoped that President Roosevelt, who returned to Washington from his Western trip on Thursday night, might visit the Railway Appliance Exhibition on Friday; but pressure of official business prevented, and the gates of the exhibition were finally closed at noon, and the work of dismantling the exhibits was at once begun. On Friday afternoon the delegates were entertained at a reception and garden party given by the President and Mrs. Roosevelt in the White House grounds.

The social functions of the Congress concluded with a dinner at the Raleigh on Saturday evening, given by the Permanent Commission of the Congress to the American Railway Guild. Mr. Ernest Gerard acted as Master of Ceremonies, and among the after-dinner speakers were Secretary Shaw, Mr. Theo. N. Ely, Secretary-General Weissenbruch, Mr. W. F. Allen, Mr. Menzik, Mr. Von Leber and Baron Moncheur.

On Sunday evening the delegates started from Washington on two excursions, tendered them through the courtesy of American railway companies. Nearly 300 were taken on the "long tour," and about one-third as many on the "short tour." Three special trains of Pullman cars were provided for the party taking the long tour. The itineraries of the two excursions is as follows:

LONG TOUR.

Monday, May 15, 7.30 a. m. Arrive Altoona, where the day will be spent visiting the Pennsylvania R. R. shops.
Tuesday, May 16. Pittsburg. Special train leaves Union Station 9 a. m., to convey party to various industrial works. Luncheon tendered by Westinghouse Companies at East Pittsburg. Leave Pittsburg via. P. C. C. & St. L. Ry., 5.30 p. m.
Wednesday, May 17. Arrive Cincinnati. Headquarters during the day at Grand Hotel. Choice of three excursions.
Thursday, May 18. Arrive at St. Louis, 8 a. m. Visit plants of American Car & Foundry Co., St. Louis Car Co. and Country Club.
Friday, May 19. Leave St. Louis via. Ill. Central R. R., 9 a. m. Stop at Springfield to visit tomb of Abraham Lincoln; arrive Chicago, 7 p. m.
Saturday, May 20, Excursion to Pullman and Illinois Steel Co.'s works.
Monday, May 22. Visit Parks, Stockyards and Drainage Canal. Leave Chicago 7 p. m., via. Grand Trunk.
Tuesday, May 23. Day spent at Niagara Falls.
Wednesday, May 24. Travel to Montreal, with stop at Toronto during forenoon. Carriage drive about Montreal and dinner at "Montreal Hunt" in evening.
Thursday, May 25. Leave Montreal 9 a. m. Arrive at Saratoga 2.25 p. m.; balance of day spent at Saratoga.
Friday, May 26. Day spent at Schenectady: American Locomotive Works, 10 a. m. to 2 p. m. General Electric Works, 3 to 5 p. m.
Saturday, May 27. Travel to New York via Hudson Day Line Steamer.

SHORT TOUR.

The party taking the short tour will travel with the other party until Pittsburg is passed, and will then diverge to the north.
Wednesday, May 17. Day will be spent in Cleveland, O. till 1.30 p. m., when train will be taken for Buffalo.
Thursday, May 18. Day will be spent in Buffalo concluding with reception and banquet at the Iroquois Club.
Friday, May 19. Day spent at Niagara Falls.
Saturday, May 20. Day spent in Schenectady till 3.30 p. m., then via Boston & Albany to Boston.
Sunday, May 21, and Monday, May 22. Spent in Boston. Leave Monday, p. m., by Fall River line for New York.

A RAILWAY EXHIBITION is to be held at Milan, Italy, from May to November, 1906, in connection with the celebration of the opening of the Simplon Tunnel. It will include an historical section, and in addition to exhibits illustrative of all departments and improvements of railway work special attention will be given to securing extensive exhibits of railway appliances.

NEW RULES governing the conditions of service salaried employees of the Panama Canal Commission were announced by the Commission on May 11. The new rules have been framed to allay discontent and complaints and it is hoped will reduce the percentage of resignations.

Among the important features of the rules relating to employees whose salaries are on a monthly or annual basis is the provision of free transportation, including meals, from the port of departure, and the provision that they may be granted, in the discretion of the head of the department in which employed, leave of absence at the rate of six weeks for each twelve months of service, or at the rate of 3¼ days for each full month's service actually rendered. This leave is to be cumulative for a period of two years, and to be granted at any time after eight months' service, in the discretion of the head of the department.

The Government rate of $20 each way on steamers of the Panama Railway & Steamship Co., operating between Colon and New York, will be allowed, should those on leave desire to visit the United States. While the grant of leave is not to be considered a vested right, it is made with a view to promoting the welfare and interests of the service.

Free medical and hospital attention will be provided in cases of illness, and, free transportation home on termination of a satisfactory service, and the Government rate of transportation between New York and Colon will be allowed for immediate members of the families of employes when the exigencies of the service will permit.

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In requesting change of mailing address, state BOTH old and new address; notice of change should reach us by Tuesday to be effective for the issue of the current week. The number on the address label of each paper indicates when subscription expires, the last figure indicating the year and the one or two preceding figures the week of that year; for instance, the number 325 means that subscription is paid to the 32d week (that is the issue of Aug. 10) of the year 1905; the change of these figures is the only receipt, unless one is sent by special request.

ADVERTISING RATES will be furnished upon application. "Want" and "For Sale" notices (especial rates) see pages 26-27. The pages for new "Want" "Proposal" and "For Sale" advertisements are held open until Wednesday noon.

CLASSIFIED ADVERTISEMENTS for Engineering News may be left at the office of the Allen Advertising Agency, 617 Sixth Ave., near 36th St., or at any office in New York City of the American District Telegraph Co. Copies of "Engineering News" may be purchased at Allen Advertising Agency. The advertisements may be keyed so as to have answers addressed to any offices of the above-mentioned companies. Out of town orders for advertisements or copies of the paper must be mailed to the head office, 220 Broadway, New York.

WHEN WE NOTIFY you that your subscription will expire please to send your renewal at once, in order not to miss a number, using the special blank enclosed for that purpose. New subscriptions which are received by us on, or before, Tuesday of any week will begin with the current issue. If they are received after that day they will begin one week later. We cannot enter subscriptions to begin with back numbers. One week's notice is necessary before a change of address can be made.

The success of the American Railway Appliance Exhibition in connection with the International Railway Congress at Washington last week exceeded, we believe, the highest expectations of those who planned it or of the exhibitors who participated. The idea at the outset was that it offered a remarkable opportunity to show to representatives of foreign railway companies the products of American manufacturers of railway supplies, and thereby open up new avenues of foreign trade. It was the general testimony of the exhibitors at the close of the Exhibition, however, that the careful study paid to their exhibits by the high officials of American railways and the large attendance of such officials, was even more gratifying to them from a business standpoint than the attention they received from the foreign visitors.

Much credit for the success of the exhibition is due to the railway presidents who attended at the opening of the Congress, and who had the breadth and wisdom to perceive the educational value of the exhibits. They forthwith sent in orders for their subordinate officials to come to Washington.

It is generally conceded that no such complete and extensive exhibit of American railway appliances has ever been brought together, even at the International Exhibitions at Chicago or St. Louis. Yet the whole exhibition was conceived and installed in an incredibly brief time; and had its scope been fully realized by the manufacturers of the United States in time to make full preparation, there is no doubt that the space occupied would have been twice as great.

The remarkable success of the Exhibition was due to the fact that it was designed for and appealed to a special class. It was among exhibitions, in fact, what the well-ordered technical journal is among publications; and this leads to the thought whether such exhibitions are not destined to be the successful exhibitions of the future. It is of no particular value to a manufacturer of rail joints, for example, to show his products to the thousands who crowd the aisles of a "World's Fair." The attention of one railway officer is of more importance to him than that of a thousand who are actuated only by idle curiosity.

So much was this fact impressed upon the exhibitors at Washington that there was already talk among them of organizing an exhibition of American Railway Appliances on even a larger scale.

As most of our readers are aware, there has grown up a custom of holding exhibitions of appliances in connection with a considerable number of the annual conventions of the technical societies. The most notable are those held at the meetings of the Master Car Builders and Master Mechanics' conventions; but there are more or less exhibits also at the American Railway Engineering Association, the Roadmasters' Association, and a large number of other railway organizations. The same thing is done in the electric railway field, the water-works field, the electric lighting field and elsewhere. If now it were possible for all the railway associations, for example, to agree upon one place of meeting for their annual conventions in any year, the manufacturers of railway supplies could organize an exhibition there which would far exceed in completeness even that just held at Washington. Such an exhibition might continue for a month or even two or three months, as long as might be necessary to give time for the various conventions to hold their meetings one after the other.

The attractions of such an exhibition would be so great that we risk little in saying that while nearly 400 exhibitors took part in the International Congress Exhibition, the number which would take part in such an exhibition as we have outlined might easily exceed a thousand. Displays to continue for two or three months would be made far more elaborate than those intended to last only for a brief period of ten days.

Further, it would be possible in an exhibition definitely planned for and organized a long time in advance, to classify and group exhibits for convenience of study in a manner that was hardly attempted at Washington. Thus the Signal Engineers' Association, for example, coming to hold its annual meeting, would find all the devices of particular interest to its members grouped in one part of the grounds.

It seems hardly necessary to discuss the educational value of such an exhibition; yet there seems to be still a more or less prevalent idea that it is in some way undignified for a technical society or let us say an engineering society to countenance in any way the holding of exhibitions in connection with its meetings. Where this notion comes from it would be difficult to say; but at the present day it is an absurdity and nothing else. Why should an engineering society listen to and discuss in its sessions a learned paper on, let us say, valve gears for locomotives, and sternly frown on an exhibition of such valve gears from which, if properly planned, the average member would gain much more information than from the printed paper?

There are certain professional societies which would hold in extreme abhorrence the idea of any exhibition of engineering appliances in connection with their meetings, and yet these same societies as they hold their conventions in one part or another of the country do not scruple to accept lavish entertainment furnished by contributions from manufacturers of these same appliances. If it is highly objectionable to have a manufacturer's products on exhibition at a convention, it is many times more objectionable to accept a hospitality that cannot be reciprocated.

We allude to this matter here because the only stumbling block that we see to the success of such an exhibition as is above suggested is the possible attitude of some of the societies concerned. Fortunately, however, the organizations of railway officials are generally controlled by men of a practical turn of mind. We believe that if the plan were properly presented, the holding of a great exhibition of railway appliances once in every three to five years, and concentrating all the meetings of the railway associations for that year at that place would meet with general and hearty approval.

Further than this, if there were brought together at one place of meeting, all the principal associations of railway officers in the country, together with a complete exhibition of American railway appliances, there is little doubt that to that same place would come the annual conventions of the associations in the street railway field and a considerable proportion at least of the engineering societies. It is to be hoped that sooner or later the plan above set forth may be put in shape for practical realization.

LIGHT RAILWAY PROBLEMS IN AMERICA.

Light railways merit in the highest degree the attention of public authorities. Their construction makes it possible to encourage the progress and development of districts which previously have remained in the background and it is accordingly not only the interest but the duty of the governments to assist them. It is desirable, therefore, not to adhere to old types and old methods of construction, operation and regulation, but to introduce every facility possible, adaptable to local needs and available resources. It is also desirable that state governments and local authorities should accord to light railways, either under the form of subsidies, relaxation of requirements or other methods of assistance, the support which they need, both for construction and for operation, so that all parts of the country may be adequately served. When the authorities of a country do not themselves construct or work light railways, and turn them over to private companies, it is indispensable that the terms of the concession should be so defined as to harmonize the interests of the working company with those of the public.

As one reads the above formal "conclusion," solemnly adopted by the Light Railways Section of the International Railway Congress last week, the first thought that comes to an American engineer is of surprise that so important and dignified a body should think it worth while to gravely adopt as resolutions, statements concerning which no American engineer has any doubt whatever. The natural rejoinder in this country to such a statement as that just quoted is, "Why, of course!" It is an elementary principle of railroading in this country that the way to build up the business of a main line is by the construction of branch lines or "feeders." Of course, the development of a district without railway transportation will be aided by building a branch line into it; and better a branch line with the cheapest possible construction than none at all.

But, while all this seems like threshing over old straw to an American, the European railway officer, brought up under a rigid system of government regulation, views the subject from an entirely different standpoint. In most parts of the United States there are as few formalities and as little expense involved in organizing a railway company, armed with the power of eminent domain to condemn private property for its right of way, as there are in the purchase of a farm. In the old and densely populated countries of Europe, on the other hand, railway construction is hedged about with a hundred difficulties and formalities. In many countries the laws contain certain requirements regarding railway operation, which, while eminently proper so far as they apply to main line railways, are wholly unsuited to the conditions existing on branch lines of thin traffic. These requirements have, consequently, operated to prevent the construction of such branch lines. The trouble has been that the lawmakers have regarded a railway as a railway, whether it carried a traffic of ten thousand tons per annum or ten million. Indeed, railway men themselves have often been little wiser. Even in this country there is widespread ignorance concerning the elementary principles of economic transportation; and the papers and discussions and formal conclusions at the Congress, therefore, are likely to have educational value, even in America.

The light railway agitation is founded on the important economic principle that *a railway should be adapted to the traffic it has to carry.*

If lawmakers of Europe have erred through ignorance, in making all railways conform to one set of fixed standards, a similar error has been committed in this country. Hundreds and even thousands of miles of railway have been built whose only reason for being was to make profits for promoters and construction companies. When built they have been incorporated into large systems—for no better reason ofttimes, it must be confessed, than to make money for insiders at the expense of the stockholders. The present day management finds itself responsible for the operation of a system with magnificent mileage but made up of profitable main lines and unprofitable feeder lines which might in fact be more appropriately designated as "suckers."

The problem of the American railway manager is how to operate these branch lines so that they shall not be an undue burden on the main line. Let it be understood that we are speaking now only of branch lines of thin traffic and on which the traffic is bound to remain thin and cannot be stimulated by an increase of traffic facilities.

If these traffic lines form part of a large system, there is sure to be a constant demand from the people living along them for better facilities, more trains, higher speeds, better station service, and withal for lower rates. If the public doesn't get what it wants, appeals will be made to the State Railroad Commission to compel the additional service to be furnished; and such compulsion is not infrequently exercised. It seems to be thought that because a "rich company" is operating a branch line it is under obligation to give to the public a service on such a line conforming to standards fixed by what it furnishes on the main line.

There is one and only one justification for this idea. If we regard a railway corporation as a great monopoly, charged with the duty of furnishing transportation facilities for a whole district or country, as the Government would do if it operated all the railways, then it may be said that the railway company, as a part of its return to the public for the enjoyment of the franchise for its profitable main line, ought to bear the burden of the unprofitable branches, whose operation is necessary for the public service.

But our American railway corporations are not organized on any such theory; and unless and until they are, it is difficult to see how they are obligated to operate unprofitable branch lines. In other words, under our American system, the public on any given line of railway is entitled to such service as the traffic it furnishes to that particular line will pay for. Suppose, for example, that every branch railway were operated by an independent company. It will be evident at once that on any given line the receipts would have to at least equal the operating expenses, fixed charges and taxes, or there would be a receivership. If this occurred, and after scaling down the fixed charges to a point where the value of the property was practically wiped out, there still remained a deficit, the road would then have to be abandoned, and that is what has actually occurred to quite a number of railway lines in this country.

The alternative to this is to reduce the service and increase the rates charged to a point that will enable the railway company to continue in business.

Actually, however, the great bulk of the branch line railways in America are owned and operated by the great companies; and as no separate account is kept of their earnings and operating expenses, there is no means of demonstrating that a given line is receiving more service or lower rates than it is justly entitled to by the volume of its traffic contributions. Indeed, American railway officials are often unaware how very unprofitable and how much of a drain upon the company's revenues some of their light traffic branches actually are.

We are by no means advocating here a return to the system of independent operation by the cutting off of these branch lines. On the contrary, it is greatly to the public advantage that branch lines should be operated as parts of a great system. A company like the Pennsylvania or the Chicago & Northwestern or the Grand Trunk can operate branch lines far more efficiently and economically than they could possibly be operated by small local companies. What we do urge is a more general recognition of the cost of service on light traffic railways, so that the railway companies shall not be compelled to furnish service at a loss or to carry traffic at rates which do not yield a fair return.

It would doubtless be unwise at the present time to establish separate accounts of earnings and expenses for each separate line of a great system; but with the tendency toward greater control by State and National Government over railway operations, it may yet become necessary to do so in order to prove to the public authorities that shippers and travelers are entitled under any circumstances to no more than what they will pay for.

There is another aspect of the light railway problem, as it is represented in the United States, that deserves a word of comment here. We have emphasized above that a railway should be adapted to the traffic it has to carry; but there seems to be some tendency at the present day to overlook this fact. In the days, not so long ago, when the standard freight-car capacity was ten tons and the old "American" eight-wheel type of locomotive was almost universal, it was proper enough to plan every railway line to carry standard rolling stock; but with the present day 100,000 lb. freight cars, the long, heavy Pullman cars, and the heavy high-speed locomotives, we believe that there is a large mileage of light traffic lines on which it will never pay to strengthen track and bridges to carry heavy rolling stock. Further than this, in the construction of new branch roads at the present time, a careful forecast of traffic probabilities ought always to be made, and in many cases economy will be best subserved by planning for the lightest class of rolling stock to run over it and for that alone.

We are well aware that the objection which will be at once raised to this idea is that it makes necessary more or less transferring of freight at junction points; but on light traffic this matter is not so formidable as it may seem. The cost of transferring freight from one car to another is not more than 10 cts. to 15 cts. per ton, and on a branch line handling even 10,000 to 20,000 tons per annum this will often be much less than the added cost of track and bridges able to carry the heaviest loaded cars.

Turning now to another resolution adopted by the Congress—that favoring the relaxation of Governmental restrictions to enable light railways to be operated in an economical manner—it may be said at once that this applies to foreign railways rather than American. In this country, railway companies have been left free, for the most part, to operate their lines in as primitive a manner as they chose; and whatever evil results may have accrued, it has at least favored the economical operation of thin traffic lines.

Probably our greatest error in operating thin traffic lines in the United States is the use of too high speeds. On thin traffic railways, danger from collision is so small that if low speeds be strictly adhered to there will be no question as to the safety of operation, signaling systems of any sort will be unnecessary, and, most important of all from the economic point of view, the cost of track maintenance and supervision can be greatly reduced.

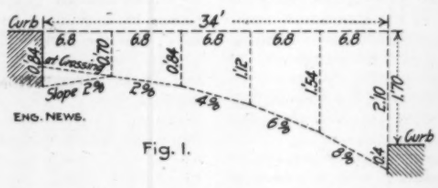


Fig. 1.

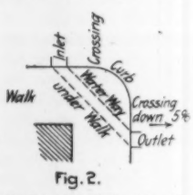


Fig. 2.

Here again the railway manager who adopts low speed for a branch line is quite sure to be met with protests from the public and even from his own operating force—so accustomed have American railway men become to taking risks by running at high speed over rough track. But the proper answer is that the public is entitled to only such speed as it pays for. If the public is willing to pay what high speed actually costs, well and good; but the actual cost of high speed on thin traffic lines is seldom fully appreciated.

The final conclusion of the Light Railways Section, recommending the use of motor cars for light passenger traffic, is a piece of counsel which American railway managers will do well to heed. By motor cars we mean, of course, cars operated by an independent motor mounted directly on the car. Our readers are already familiar with the extensive use which European railways are making of this type of car; and if they are found economical in densely populated Europe, much more ought they to prove suited to the conditions existing on a great mileage of American railways.

The success of the motor car for light traffic, however, is closely dependent on the matter of speed, already referred to. One reason for the failure of the motor cars which were tried on several American railways several years ago was that the designers attempted the impossible. They set out to make a motor which should be capable of moving a heavy, full-size passenger coach at speeds up to 60 miles an hour and hauling one or two trailers besides. As the machine necessarily had the power of a small locomotive, the almost inevitable result was that the car rode more like a locomotive than a passenger coach.

This is, in fact, another illustration of the importance of low speeds for the economical movement of light traffic. With low speeds the motor car can be made a success where it could not at high speeds. While there will be, of course, many tests at speed limitations, the public convenience will often be better served by a moderate speed service at frequent intervals than by a high speed service and fewer trains. This is admirably illustrated by the popularity of electric surface urban trolley cars as compared wth higher speed steam railways.

As has been before pointed out in these columns, the attention of engineers and railway managers has for years been concentrated on the lines of heavy traffic. The ablest minds have been dealing with the difficult problems of safe passenger movement at high speeds and freight movement in large units and the provision of rolling stock, permanent way and terminal facilities suited to such conditions. Meanwhile the equally important problems in connection with the economic movement of light traffic have been almost wholly ignored.

It is to be hoped that the work of the Light Railways Section of the International Congress may be fruitful in turning attention toward these problems.

LETTERS TO THE EDITOR.

Design of the Cross-Section of a Street Having Curbs at Different Elevations.

Sir: Herewith I submit reply to "S. H. C.," page 370, in your issue of April 10.

Make face height of upper curb 0.84 ft., of lower one 0.40 ft., as in Fig. 1. Measure the ordinates down from the level of the upper curb as shown. The limit of slope for any portion of cross-section should be 10%. Make the face of the curb at crossings not more than 0.5 ft. nor less than 0.3 ft. If required, water in gutters may be passed under sidewalk back of curb, as in Fig. 2.

For level cross-section I prefer the following, using 8 divisions: 1.0, 0.6, 0.3, 0.1, 0.0, 0.1, 0.3, 0.6, 1.0. For example, the crown is 0.5 ft.; the ordinates will be 0.5, 0.3, 0.15, 0.05, 0. The formula often used is 16, 9, 4, 1, 0, which reduced to decimals would be 1.0, 0.5625, 0.25, 0.0625, 0. Taking 0.5, as in example above, the ordinates would be 0.5, 0.28, 0.125, 0.03, 0. By comparing the examples it will be observed that the first gives more transverse slope at center and less at the curb.

Respectfully, Holland Wheeler.

Lawrence, Kan., April 10, 1905.

Pressure Against Handrailings

Sir: Some very interesting articles on "The Weight of Crowds" have been published recently in your journal. Closely connected with this matter is another: the question of the maximum pressure that a congregation of people may produce against handrailings, but as far as I know very little information on this matter can be gathered from technical books. Dubois (Framed Structures, 8th edition) gives absolutely nothing; Johnson (Modern Framed Structures, 2d edition, p. 344) mentions iron handrails and fences, but makes only some general remarks as to their construction. In some European handbooks (e. g. Handbuch der Ingenieurwissenschaften) various figures are given, but it is not apparent whether these figures are based upon actual experiments or whether they are merely guessed at. Without doubt, however, you will admit that the question is of great interest, and I beg leave therefore to ask through your columns if any of your readers have any knowledge of experiments bearing upon the matter.

Respectfully yours,

Fr. V. Meyer, C. E.

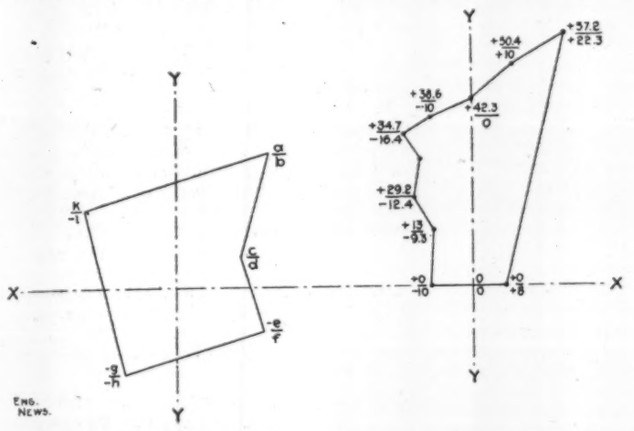
Copenhagen, Denmark, April 26, 1905.

Eckel's Formula Applied to Irregular Cross Section Area Without Plotting.

Sir: Referring to your issue of Dec. 22, 1904, p. 576, and to Jan. 19, 1905, p. 77, it may be interesting to apply Eckel's formula to the cross-section in question.

Eckel's formula can be used without plotting the sections, and is generally adopted to the easiest or most difficult rectilinear areas. This formula, which is mathematically correct, is:

If the corners of any rectilinear polygon be referenced by rectangular coordinates to any origin, then if the ordinate of every corner be multiplied by the abscissa of the next corner, and so on around the polygon, and these products added together; and if the ordinate of every corner be again taken and multiplied by the abscissa of the



next corner, passing round the polygon in the reverse direction, and these products added together, then the area of the polygon is equal to one-half of the difference of these two sums.

As an example in the figure, the area of the polygon is

$$\frac{1}{2}\left\{\begin{array}{l}[(a\times d)+(c\times f)+(-e\times -h)+(-g\times -1)+\\(k\times b)]-[(a\times -1)+(k\times -h)+(-g\times f)+\\(-e\times d)+(c\times b)]\end{array}\right.$$

$$=\frac{1}{2}\left\{\begin{array}{l}(a\times d)+(c\times f)+(e\times h)+(g\times 1)+(k\times b)+\\(a\times 1)+(k\times h)+(g\times f)+(e\times d)-(c\times b)\end{array}\right.$$

In railway work the area is all above the axis X X, greatly simplifying the work of calculation. In very irregular areas, as in the figure, the area is rapidly taken out, as follows:

$$\text{Section}=\frac{34.7}{-16.4}+\frac{38.6}{-10}+\frac{42.3}{0}+\frac{50.4}{10}+\frac{57.2}{22.3}+\frac{0}{8}+\frac{0}{0}+\frac{0}{-10}+\frac{13}{-9.3}+\frac{20.5}{-13.9}+\frac{29.2}{-12.4}+\frac{34.7}{-16.4}.$$

$$\text{And the area}=\frac{1}{2}\left\{\begin{array}{l}-347+423+1123.92+457.6-\\180.7-254.20-478.88+430.28+\\405.88+190.65+130\\-572+423+633.04\end{array}\right\}=1,192.26 \text{ square feet.}$$

Note that in multiplying the reverse order the numerators are all minus. This (Eckel's) is essentially the method of Messrs. Kauffman and Worley without the application of a graphical scheme to assist in computation.

J. A. Macdonald.

Hermanville, P. E. I.

Further Discussion of a Court Decision Relating to the Subdivision of Sections of Land.

Sir: In my former communication relative to the decision of the Wisconsin court in the case of Underwood et al vs. Smith et al I tried to make myself clearly understood. I find by your issue of May 4 that Mr. Chas. H. Gillett has both misunderstood and by garbling my words has misrepresented what I wrote, hence I ask a little more of your space for a reply. The garbling occurs where Mr. Gillett quotes my words that "The Wisconsin decision is bad law and should not be followed," but omits the first part of the sentence which states clearly that this applies only to the east and west lines of Sections 1, 2, 3, 4, 5 and 6 and to the north and south lines of Sections 6, 7, 18, 19, 30 and 31. As applied to other lines in the township the decision is sound and good law. Mr. Gillett says that "a meane course between the north and the south lines of the section as ordered by the court will correspond exactly with a line made parallel with the south line of the section." Is that true? If the two lines are parallel then there is no meene course and no question arises. If they are not parallel a mesne course between them cannot be parallel with either of them, either in the "five span mathematics" alluded to by Mr. Gillett, nor in fact on the ground nor in law. That is a mathematical, actual and legal impossibility. Mr. Gillett gives as his reason why the meene line would be parallel with the south line "because the surveyor would place the east quarter post of the Section 6 referred to at a point in the east line of that section, 40 chains original measure from the southeast corner of the section." No he would not because he could not. The case decided by the court and criticised by me is one "where no such corner has been or can be fixed." That was stated distinctly. The wording of the law "has been or can be fixed" distinctly implies that if the corner can be fixed it should be done and the lines run accordingly as Mr. Gillett says. But that is not the case under discussion.

There are a number of other points of interest to the surveyor and land owner brought out in the case under discussion which I purposely avoided touching upon which do not appear to me to have been satisfactorily settled by the decision. These questions are caused by the bad work of the original survey. For instance the east quarter post was not set by that survey by reason of a lake. A meander post was set on the south bank of the lake. The distance from the southeast corner of the section to this meander post is much greater than that returned in the field notes, while the distance from the meander post to the section corner north is about a corresponding amount less than that given in the field notes. That brings up these questions: First, should the surveyor in locating the half-quarter corner between the southeast corner and the meander corner prorate the distance between those two corners or not? The court's decision was that he should not, but should ignore the returned distance between those corners. The decision does not say so in so many words, but that is necessarily implied. The same question comes up in regard to locating subdivision points north of the meander corner. There seems to me a good opening for discussion of these questions, but that no hard and fast rule is likely to be adopted which will cover all cases of discrepancies between the field notes and the actual facts.

F. Hodgman.

Climax, Mich., May 6, 1905.

Notes and Queries.

W. G. asks where he can find data or formulas for the frictional resistance of air in large conduits, such as railway tunnels and ventilating shafts.

E. L. Leasman, 613 Francis St., Madison, Wis., writes as follows:

I am endeavoring to gather material on the history of machine tool manufacture in both Europe and America. As I find very little authentic material on this subject, I take the liberty of asking your readers if they can give me any references. I would be very grateful for any personal knowledge they may have, as well as hints as to sources of information.

ANNUAL CONVENTION OF THE AMERICAN WATER-WORKS ASSOCIATION.

The twenty-fifth annual convention of the American Water-Works Association was held at West Baden, Ind., during the week beginning May 13. Considering the out-of-the-way location the attendance was fair. It was thought by many that the lack of outside attractions, or detractions, contributed largely to the interest shown in the business sessions. Liberal provision was made for the amusement of the members and guests during the unusually ample periods between the deliberations of the convention, which were strung out over practically a whole week. No little inconvenience and expense was caused a number of the members by a misunderstanding which limited the sale of going tickets, with provisions for reduced fare in returning, to May 4 to 7, thus compelling those who started later than Sunday to pay full fare for the round trip. This circumstance, combined with the way the program was spread out over a whole week and the strange location of the meeting place suggested the idea that the convention was planned quite as much for hotel as for water-works interests, but undoubtedly this was not the case. Evidently, however, no one would have thought of going to West Baden had there not been some active hotel promoting work done a year ago. But it should be remembered that locating a convention where ample hotel accommodations at reasonable prices can be found is at best a troublesome task.

In the presidential address of Mr. Morris R. Sherrerd, M. Am. Soc. C. E., of Newark, N. J., attention was called to the fact that the membership at the opening of the convention included 385 active, 71 associate and 7 honorary members, a total of 463. Mr. Sherrerd suggested further work on standard specifications for water-works materials and on fire protection improvements.

PRIVATE FIRE SERVICE METERS.

The report of the Committee on Fire Insurance awakened much interest and both it and the supplementary report on a standard thread for hose couplings were adopted. The members of the committee were C. H. Campbell, Chairman, A. E. Boardman, Geo. H. Felix, M. R. Sherrerd and F. W. Shepperd. The committee reiterated its conviction that fire protection service being a valuable consideration—

private fire service should be paid for by the owners of the property so safeguarded and protected; and that the appliances for introducing and measuring the water so used should be paid for by said owners just as much as the piping, hydrants and sprinkler heads inside the buildings or premises.

The reporting committee acknowledged the co-operation of associate members and of the private fire service committee of the National Fire Protection Association, of which committee Mr. E. V. French is chairman. The water-works and fire interests named united in approving

an apparatus embodying an indicating valve which shall not afford an initial resistance greater than about 6% of the available pressure, with a metered by-pass.

The committee also presented descriptions of two devices intended to meet the requirements just named and recommended the trial of the devices by members of the association. The first device is credited to Mr. French and the second to Mr. J. A. Tilden, General Manager of the Hersey Manufacturing Co. The descriptions are as follows:

FIRE SERVICE METER DESIGNED BY THE INSPECTION DEPARTMENT OF THE ASSOCIATED FACTORY MUTUAL FIRE INSURANCE COMPANIES.

This meter is a development of the familiar meter system consisting of a weighted check valve in the main pipe with a small indicating meter in a by-pass around it. This indicating meter records at all times the flow of water through the by-pass. Water is prevented from running backward through this indicating meter by small check valves. A strainer of generous proportions protects the indicating meter works from obstruction, and is so arranged that the debris that is collected is washed out by every large flow through the main check valve.

The main check valve is provided with two concentric seats, the angular space between them open to the atmosphere. Any leakage past either seat in either direction is indicated at once by a discharge of water from this space. It is evident that since the larger seat is acted on by the pressure existing ahead of the clapper, this pressure may be reduced considerably before its effect on the clapper will equal that of the original pressure back of the clapper acting on the smaller seat. When this occurs the rubber-faced clapper will leave its seat and will take a position dependent on the amount of water passing at the time.

When a small flow occurs the water passes through the indicating meter, which records the quantity on the dial A, and then through the opening for the horn to the main pipe again. The clapper remains on its seat as the quantity increases until the pressure ahead of the clapper is reduced by the loss of pressure due to friction or other causes in the by-pass to the amount at which the clapper leaves its seat.

The horn or regulating valve moving with the clapper enters the opening provided for it and reduces the quantity of water passing through the by-pass to one-tenth of that passing the main clapper, and is shaped so that it maintains this proportion constant for all larger flows through the device. By a simple mechanism, Dial B is thrown into action when the clapper leaves its seat, and records what water passes the main check valve by multiplying the measurement of water through the by-pass by the constant coefficient—ten. Dial B is thrown out of use when the clapper is re-seated, and the total flow passes through the by-pass again.

When the clapper leaves its seat, the force acting to keep it here during the small flows is destroyed and a weight is provided to assist the clapper in closing.

The principal results accomplished by this device are as follows:

(1) Small and large flows are measured accurately. (2) Excessive friction loss is avoided. (3) A clear passage for large flows is assured. (4) Indication of the tightness of the main check is given. (5) Indication of the rate of consumption is given; that is, whether the consumer takes large or small quantities at a time. (6) An efficient strainer is provided which is kept clean automatically.

HERSEY DETECTOR METER.

This device is to be known to the trade as the "Hersey Detector Meter." Its object is fairly indicated by its

name, viz., that it will accurately measure all drafts, say, up to 150 gallons per minute, and that it will detect and exhibit whether or not any additional quantity in excess of this amount has passed the device.

Broadly stated, this detector meter consists of an indicating detector check valve on the main fire line, and a meter on a by-pass around the detector. There is no mechanism on the main fire line except the detector, a device which possesses no appreciable resistance, but which, on the other hand, always presents an unrestricted waterway for use in case of fire.

What the detector does is, first, to cause all drafts up to about 150 gallons per minute to go around through the by-pass meter, where they are all measured; second, to give a positive indication that, while this is going on, no water is passing through the fire line; third, to give a postive indication, if the draft exceeds 150 gallons per minute and just how many hours such an excess has been going on. It may even be made to indicate just when it took place.

The device is absolutely without objection from the underwriter's point of view, and seems to be equally satisfactory from the water-works standpoint. It must be remembered in this connection that this device is designed to be used on a class of service where it will be unlawful to use any water whatever except in case of fire.

It would, therefore, seem abundantly qualified to fill the chief requirements which appear to exist for a device that will accurately meter all leaks or ordinary small drafts other than fire; that will give an unrestricted water way for use in case of fire; and that will detect and show if water has been used in very large quantities, say in excess of 150 gallons per minute.

STANDARD FOR HOSE AND HYDRANT COUPLINGS.

The Fire Insurance Committee, working in co-operation with a committee of the National Fire Protection Committee (F. M. Griswold, chairman of the latter) reported the co-operation of numerous manufacturers in their labors on standard thread for hose couplings, and an agreement to the effect that the thread best adapted for universal service and that must quickly be brought into general use was 7½ threads per in. on a nozzle with diameters of 2½ ins. internal and 3 1-16 ins. external.

The recommendations made by the water-works committee, and adopted by the association, in conformity also with the ideas of the fire committee, were as follows:

We recommend for adoption the following specifications and details covering a practical and acceptable standard, viz.:

Inside diameter of hose, ins.....	2½	3	3½	4½
Number of threads per inch	7½	6	6	4
Male Couplings:				
Outside diam, of thread, ins...	3 1/16	3⅝	4¼	5¾
Depth of thread, ins.....	.113	.142	.142	.211
Diam. at root of thread, ins...	2.873	3.377	5.002	5.40
Clearance between male and female threads, ins.....	.03	.03	.03	.05
Length of threaded male end, ins.	1	1⅛	1⅛	1⅜

The above to be of the 60.0 V-thread patterns, with 0.01-in. cut off the top of thread and 0.01-in. left in the bottom of valley in 2½, 3 and 3½-in. couplings, and 0.02-in. in like manner for the 4½-in. couplings, and with ¼-in. blank end on male part of coupling in each case. Female ends to be cut ⅛-in. shorter for endwise clearance. They should also be bored out 0.03-in. larger in the 2½, 3 and 3½-in. sizes, and 0.05-in. larger in the 4½-in. size in order to make up easily and without jamming or sticking.

Your committee would further state that while making our investigations leading up to the above recommendation, we were struck with the equal importance and desirability of recommending for adoption a standard nut to be used upon the operating stem of hydrants and the auxiliary valves of the same, together with the nozzle-caps; and also with regard to the weight of the couplings to be employed in the hose connections themselves; and we would suggest that these two matters be referred to this committee for conference with other organizations in the same way as has been done with the standardization of hose thread couplings, to endeavor to also standardize these important auxiliaries.

WATER RATES FOR FIRE AND DOMESTIC SERVICE.

Mr. S. J. Rosamond, of Fort Smith, Ark., presented some tables of water rates for private and public service compiled from special returns made at his request by 70 water companies. He noted a wide range of hydrant rentals "without any apparent cause, from $79.25 to $21.50 with an average of $44 per hydrant per annum. An average of eight hydrants per mile of main was also noted. He suggested as a basis for hydrant rentals a fair return on the extra investment due to fire protection, which for cities in the Southwest has been placed by Folwell (in his "Water Supply") at from 33⅓ to 47% of the cost of domestic supply alone. Where filtration is practiced, an allowance for this should also be included in the calculations. Free water for school and other municipal service was condemned, and it was urged that the charge for fire protection and for all other municipal purposes should be separate. For domestic consumption meters were advocated.

In discussing the paper a difference of opinion was shown as to there being any ground for considering filter plant cost in fixing hydrant rentals. Some held that filters need not be made appreciably larger on account of the fire service, but in reply Mr. Rosamond urged that, though small, there is an appreciable increase in construction charges, due to filtration. Mr. J. M. Diven favored charging a lump sum per mile for fire protection, and then allowing the city to supply at its own expense all the fire hydrants it chose. The average of eight hydrants per mile, shown by the table, is altogether too small.

The enormous waste of water by sewer flush tanks, as ordinarily fed, was mentioned by several. A perforated disk for a feed has given satisfactory results. Comment was made on the general indifference of other city departments to the efforts at waste control made by the water department, and it was asserted that "every tub should stand on its own bottom"; that is, pay for the water used by it.

THE COMMERCIAL PUMPING ENGINE.

In a long and well-received paper on this subject, Mr. Chas. A. Hague, M. Am. Soc. C. E., analyzed in detail the requirements, as he conceived them, for a pumping engine specification. In opening, he commented on the almost complete displacement of the specially designed by the commercial pumping engine, and the fact that the results obtained by the latter class now equal or exceed those given not long ago by special pumping engines. He favored limiting the responsibility of manufacturers of pumping engines to the machine itself, even to the exclusion of painting. The check now required with bids he considered of but little use. Towards the close of his paper Mr. Hague said:

The adaptation of a pumping engine to its conditions, so far as may be, is the key to highest efficiency under the conditions imposed. There are advocates of high speed, of high steam pressure, of high rate of revolution, and other singled out and isolated factors, but the general combination wherein the machine best meets the conditions is what will yield the best results, and not the exploiting of any particular seemingly important factor by itself. And, as an example of this fact it may be noted that the pumping engine in this country, if not in the world, which holds the high duty record has the following conditions to work under:

Capacity per 24 hours, 15,000,000 U. S. gallons.
Piston speed, 197 ft. per min.
Rotative speed, 20 revs. per min.
Water load against pumps, 126 lbs. pressure.
Steam pressure per gage, 126 lbs. pressure.
Indicated power, 802 HP.
Mechanical efficiency, 96%.
Steam per hour, I. HP., 10.68 lbs.
Duty per 1,000 lbs. steam, 179,454,250 ft.-lbs.

Regarding high piston speed, the best record known to the writer as to pumping engines is 607 ft. per min., where the duty per 1,000 lbs. of steam was 157,843,000 ft.-lbs., showing that higher piston speed alone will not answer.

Regarding high steam pressure the record seems to be 200 lbs. and a duty of 149,500,000 ft.-lbs., showing that high steam pressure in the absence of other ruling conditions or proper fitness falls short of the best performance.

Regarding thermal efficiency, or the actual economy of heat employed with reference to absolute temperatures, even the greatest thermal efficiency does not in the presence of adverse conditions in some other direction equal the engine working under the best general fitness of things as will be seen by the following:

Thermal efficiency.	Duty per 1,000 lbs. steam.
22.8 per cent.	149,500,000 ft.-lbs.
21.63 " "	178,497,000 " "
21. " "	179,454,250 " "
20.85 " "	173,620,000 " "
20.78 " "	176,419,600 " "

What is considered the record for general all-round efficiency for a pumping engine up-to-date is as follows:

Capacity per 24 hours, 30,000,000 U. S. gallons.
Steam pressure gage, 185 lbs. per sq. in.
Piston speed, 195 ft. per min.
Duty per 1,000 lbs. steam, 178,497,000 ft.-lbs.
Duty per million heat units, 163,925,300 ft.-lbs.
Steam per hour, I. HP., 10.335 lbs.
Thermal efficiency, 21.63%.

A possible duty of "200,000,000 ft.-lbs. or a trifle higher" was mentioned as the only likely increased duty of the near future.

Mr. Irving H. Reynolds, M. Am. Soc. M. E., in a letter remarked that there is a tendency to overdo the required amount of valve area and that some of the other requirements of the paper appeared to be too high. A good rule and an easy one to remember is to provide suction and discharge valve areas at the rate of 1 ft. per 1,000,000 gallons pumping capacity. Mr. John W. Alvord looked for an increased use of rotative pumps of small capacities.

WEDNESDAY MORNING.

At the opening session on Wednesday the various constitutional amendments proposed a year ago, and printed in the last annual report, were adopted without discussion. These were mostly minor in character.

Mr. W. R. Hill, M. Am. Soc. C. E., read a paper outlining various proposed sources of supply for New York City. "Notes on the Density, Relative Volume and Weight per Cubic Foot of Pure Water," by M. L. Holman, M. Am. Soc. C. E., was read by title.

Mr. J. P. A. Maignen, Assoc. M. Am. Soc. C. E., of Philadelphia, read a paper on a 4,000,000-gallon slow sand filter plant, with preliminary scrubbing filters, recently designed and built by him for the water company at South Bethlehem, Pa. The preliminary filter works at a rate of 48,000,000 and the sand filter at a rate of 8,000,000 an acre. A special device is used for cleaning the sand filter.

Mr. Ben. C. Adkins, of St. Louis, was elected president and Mr. J. M. Diven, of Charleston, S. C., was re-elected as secretary of the association for 1905-6. Boston was then chosen as the place of meeting next year.

SULPHATES OF COPPER AND IRON, FILTRATION AND TYPHOID FEVER.

Wednesday afternoon was devoted to these topics. Mr. Arthur C. Brown, of Lorain, O., now with the American Steel & Wire Co., read a paper on the "Practical Sterilization of Water by Copper and Iron Sulphates with Subsequent Filtration." One per cent of sulphate of copper, 99% of sulphate of iron and sufficient lime to take up the carbonic acid in the water is substituted for sulphate of alumina as a coagulant, the copper being designed as a germicide. The paper contained an interesting account of tests of the new process, compared with sulphate of alumina alone, recently made at Anderson, Ind. The process is also about to be tested at Marietta, O. We hope to take up this paper in a later issue.

"Some Experiments with Copper Sulphate" were outlined by Mr. James M. Caird, Chemist and Bacteriologist, Troy, N. Y. In his regular practice the author had treated a number of reservoirs with copper sulphate of a strength ranging from 1 part in 10,000,000 to 1 part in 1,000,000 of water.

Using the potassium cyanide test he had never found copper in the water 24 hours after it was treated. In explanation the author said the copper is absorbed by the vegetable matter in the water and settles to the bottom of the reservoir. Experimental tests for copper and tests of mechanical filters led the author to the following conclusions:

(1) That 1 part of copper sulphate in 10,000,000 parts of water can be detected.
(2) That copper sulphate when used in comparatively strong doses will slightly reduce the color of the water.
(3) That copper sulphate will reduce the alkalinity and increase the hardness of water.
(4) That water to be filtered by the American Process where alumina or iron and lime is used as a coagulant will be free from copper if the filters are properly operated.
(5) That filtration without the addition of a coagulant does not remove the copper.
(6) That the addition of lime will precipitate the copper.
(7) That when iron is present it tends to interfere with the cyanide test for copper.

Prof. W. P. Mason and others made some vigorous comments on statements in Mr. Brown's paper to the effect that in the Anderson tests sulphate of alumina failed to remove B. coli, while the copper and iron did remove it. Professor Mason thought something must be wrong with the figures. Mr. Brown said the filters, at the outset, were in poor condition. Professor Mason also suggested that the combination of the copper and iron might have a physical effect upon bacterial reduction different from sulphate of alumina. He also sounded a strong note of warning against attemps to disinfect drinking water. Copper treatment for algae is required infrequently, but treatment to remove typhoid germs must go on day and night 365 days in the year. The use of power-

chemical agents in water is sure to meet with interest from many quarters.

Asked about the cost, Mr. Brown said that for chemicals alone copper, iron and lime cost $1.97 and sulphate of alumina $3.16 per 1,000,000 gallons of water treated.

Mr. Dow R. Gwinn, of Terre Haute, Ind., referring to copper sulphate as an algacide, called attention to the fact that its use had been confined to reservoirs and that river waters sometimes had bad tastes and odors, as witness the Wabash at Terre Haute this year. Mr. Kellerman, associate of Dr. Moore, of Washington, visited Terre Haute and after investigation advised locating the origin of the asterionella in the drainage area, but the streams being ice covered this was impracticable.

Mr. F. B. Leopold read a paper on "Filtration of Public Water Supplies in Relation to Typhoid Fever Epidemics," in which he reviewed most of the principal water borne epidemics down into 1904. All the cities where these epidemics occurred, except Plymouth, Pa., and Leadville, Colo., have since put in or are putting in filters. Figures were presented to show the money cost of these epidemics and of the 50,000 deaths from typhoid fever in the United State in 1903.

PICTURES AND PAPERS.

The session on Wednesday evening was given up to papers accompanied by lantern slides. Portraits of the successive presidents of the association were shown by Mr. J. M. Diven who made running comments on the men represented.

Under the title "Turbine Engines for Water-Works," Mr. Dabney H. Maury, M. Am. Soc. C. E., described at length the De Laval, Parsons-Westinghouse and Curtis steam turbines and discussed their possibilities for lifting water. Thus far only the Turbine Engineering Co., the manufacturers of the De Laval turbine, have given much or any attention to water-works, and this only with centrifugal pumps. The possibilities of turbine pumps were discussed and numerous tables and diagrams were exhibited to show the efficiency of the steam turbine and its possibilities when used to drive pumps.

In discussing the paper Mr. A. E. Boardman said it remains to be seen what this type of machinery will do in practice. He hoped and was inclined to believe that Mr. Maury's prognostications would prove true. Mr. Chas. A. Hague, M. Am. Soc. C. E., was slightly sarcastic and decidedly sceptical about this "scientific toy." He thought it was unlikely that it would ever attain the efficiency of the reciprocating pumping engine; in fact, he went so far as to declare his belief that the highest efficiency of turbine machinery had already been reached. In reply, Mr. Maury said he had admitted in his paper that thus far a pump efficiency of only 70% had been reached, but he hoped to see an increase of 15 or 20%. He added that in many cases rotative pumping engines are advantageous, and that the vast majority of pumping engines in use are below 10,000,000 gallons capacity and do not attain the high efficiencies of the reciprocating engines which Mr. Hague had in mind.

A few lantern slides relating to deep seated waters, were shown by Prof. W. P. Mason, of Troy, N. Y.

The final paper of the evening was "The d'Auria Pumping Engine," by Mr. Luigi d'Auria, now of Providence, R. I. The author outlined the evolution of the engine and described the individual engines thus far built, ranging from 1,000,000 to 10,000,000 gallons capacity. These pumping engines are now being built by the Builders' Iron Foundry, of Providence, R. I. Recent tests of a 1,000,000-gallon engine, under a great variety of conditions, have shown notably high duties for so small a pump. These tests will soon be available in pamphlet form.

Mr. Hague made some remarks on this paper, giving the pumping engine a qualified approval and stating that its short strokes and large clearances were against high efficiencies.

BOOKS FOR THE WATER-WORKS OFFICE.

A paper on this subject was read by Mr. M. N. Baker, of the editorial staff of this journal. It included a list of some eighty books, with full particulars as to authors, publishers, size, illustrations, and the like. The substance of the paper is printed in the Literature Supplement of this issue.

Several members commented on the paper, suggesting, collectively, the addition of a book on practical hydraulics, by Randall, of San Francisco; A. R. Foote's "Law of Incorporated Companies Operating Under Franchises;" J. B. Rider's "Little Engineer;" and John R. Freeman's "Fire Streams."

OTHER PAPERS AND BUSINESS.

A paper giving experience with mineral rubber coating at Minneapolis and elsewhere, written by Mr. F. W. Cappelen, M. Am. Soc. C. E., was next read, but was not discussed.

The Committee on Publication reported that it had held four meetings during the convention, passed on the various papers presented, and tried to eliminate, in accordance with the constitution, all matter of the nature of puffs and patented and commercial articles. Mr. John M. Goodell, Assoc. M. Am. Soc. C. E., and editor of the "Engineering Record," commended highly the work of the committee, and told of the benefits which other associations had derived from similar committees.

The Executive Committee recommended the printing of an index of the Proceedings as a separate volume as soon as finished by the secretary; that the scope of the Committee on Cast Iron Pipe be enlarged and its name changed to Committee on Water-Works Standards; and that the scope of the Fire Insurance Committee be enlarged. The recommendations were adopted.

The report of Mr. John M. Diven, Secretary-Treasurer, showed 450 members, net, at the beginning of the convention, with 46 new members elected during the convention, making a membership of 496, as follows: Honorary, 7; active, 411; assocate, 78. The balance in the treasury had decreased from $114 last June to $36, but additional dues would be received before a full year had passed.

The session Thursday morning closed with several volunteer papers, beginning with one by Mr. S. A. Charles, of Lexington, Ky., entitled "A Few Practical Hints," In buying coal at Lexington bidders are asked to submit a sample carload, for which they are paid, careful records of the evaporation by this coal are kept and the coal showing the best record and the most favorable price is bought. Further evaporative records are kept during the year and additions or deductions are made in accordance with the results. The plan has been followed with satisfaction for some years. New meters are tested under working conditions and adjusted to register 1% in favor of the consumer, to lessen complaints. The meters are set in the sidewalk. One man reads 500 a day, or with a helper to raise the lids, 600. The last statement was received with surprise, but Mr. Charles explained to the members that the employees of the company were treated in a friendly manner and were interested in their work.

Mr. Van Duyne, of Newark, described an interesting set of mechanically lifted screens installed at the new storage reservoir soon to be filled by Newark. The screens are hoisted by a small gasoline engine moved on an overhead trolley by the same power, washed and replaced. The screens are made of copper plates, perforated. The design was made by Mr. C. E. Davis, Assoc. M. Am. Soc. C. E., and was carried out by Mr. Van Duyne, under the direction of Mr. M. R. Sherrerd, M. Am. Soc. C. E.

Mr. J. Waldo Smith, M. Am. Soc. C. E., sent a paper describing the towers and derricks mounted thereon, used in the construction of the southerly end of the New Croton Dam (see Eng. News, Oct. 6, 1904.)

Mr. John E. Ericsson, M. Am. Soc. C. E., City Engineer of Chicago, outlined the conditions in that city as regards pumpage and waste of water. The per capita consumption is already 200 gallons a day. New pumps of 103,000,000 gallons capacity are being added, but it is scarcely possible to keep up with the increased consumption. By 1921 it is estimated that the nominal pumpage capacity required will be 930,000,000 gallons a day. Meters are greatly needed.

The Committee on Electrolysis had nothing to add to its previous recommendations. The Committee on Uniform Annual Reports, had achieved little and wished to be dischaged, but was continued.

At an "Experience Meeting" Thursday afternoon a variety of topics were informally discussed, after which there was an adjournment, which was practically final, to see a baseball game between active and associate members, which served as an appetizer for the banquet held Thursday evening.

THE PANAMA CANAL COMMISSION has received a considerable amount of unsolicited advice from engineers and others as to the best manner of building the canal Some twenty more plans have been offered, some very crude, others bearing evidence of considerable study. While the Commission will probably refer these plans to the Board of Consulting Engineers, it is not considered probable that any valuable plan for the work can be made except by experienced engineers fully conversant with all the local conditions and with the investigations and surveys that have been made during the past year.

ELECTRIC TRACTION is to replace steam power on the Chicago and Evanston line of the Chicago, Milwaukee & St. Paul Ry., and the line will be oeprated by the Northwestern Elevated Ry., which will connect with the surface line by an extension from its present terminus at Wilson Ave. All passengers and freight traffic will be handled by electricity north of this point, and within a few years the railway will be elevated from Wilson Ave. to the city limits. A 50-year agreement has been made between the two companies, and provides for an equal division of net receipts. The cost of electric wiring and equipment will be about $1,000,000.

A DYNAMITE EXPLOSION killed seven men, May 12, in the Cora Copper Mine, near Butte, Mont. A man was carrying 40 sticks of dynamite up a ladder when the explosion occurred. It is believed that the flame of the candle in his hat touched the dynamite. The explosion of a car-load of dynamite at Harrisburg, Pa., is described elsewhere under railway accidents.

A DEVASTATING TORNADO wrecked the town of Snyder, Oklahoma Territory, and the adjacent country, on the morning of May 11, 1905. The population of Snyder was about 1,000; the St. Louis & San Francisco Ry. had a roundhouse and repair shops there. Over 100 persons were killed in the storm, most of them in Snyder. Most of the buildings in the town were wrecked. The storm formed near the Texas State line and traveled northeasterly. It was preceded by a heavy fall of rain. The storm area was fairly wide, most of Southern Oklahoma reporting destructive winds. The path of serious destruction was, however, quite narrow. A tornado-like storm was reported from Central Kansas the same day.

THE MOST SERIOUS RAILWAY ACCIDENT which has occurred for some months caused the death of about twenty persons at Harrisburg, Pa., on the early morning of May 11, 1905. A long east-bound freight train, in the middle of which was a car loaded with low-grade dynamite consigned to a contractor, was stopped by an emergency application of the brakes in the yards just east of Harrisburg. The sudden stop threw several cars in the middle of the train, among them the dynamite car, off the track and over on to the west-bound passenger track. A few minutes later a west-bound fast passenger train, from New York for Pittsburg, ran into the wreckage. The dynamite was exploded either by the collision or by fire, and the entire mass of wreckage was burned. The explosion and fire caused the instant death of over a dozen persons, and injured many others, a number of whom died during the day.

THE AMERICAN MEMBERS OF THE INTERNATIONAL DEEP WATERWAY COMMISSION, Col. O. H. Ernst, George Clinton, of Buffalo, and Prof. Gardner S. Williams, of Ithaca, met for the first time May 11, 1905, in Secretary Taft's office to learn his views relative to the assembling of the joint commission. It was resolved to invite the Canadian members to a joint meeting in Washington, May 25, when an effort will be made to select permanent headquarters for the joint commission and to agree upon the scope of its work. The language of the river and harbor act of 1902, defining the objects of investigation by this commission, is regarded by the War Department as rather vague and obscure, and Secretary Taft has called upon the Attorney General for an opinion precisely defining the purpose of the act. At the very outset, it is pointed out by the Army Engineers there is an important difference of opinion between the two sides of the commission as to the St. Johns River problem, the Canadian instructions expressly including this as a proper subject for investigation, while the War Department here takes a contrary view and proposes to let this matter be dealt with by a special commission, which it is hoped to have created at the next session of Congress.

NOTES FROM THE ENGINEERING SCHOOLS.

THE THAYER SCHOOL OF CIVIL ENGINEERING, Dartmouth College. The School closed its year April 26, and will resume July 15, beginning the season with an entering class of seniors from the College. The six graduates and the 17 members of the first year class, who have earned the B. S. degree from the College, have all secured satisfactory employment. Ten took Civil Service Examinations in March, and six have already been assigned work on the U. S. Coast and Geodetic Survey, and the U. S. Geological Survey, Topographical Divisions and Reclamation Service.

PERSONAL.

Mr. C. M. Thorpe has been reappointed City Engineer of Bozeman, Mont.

Mr. David Morey has been appointed Superintendent of Water-Works of Troy, N. Y.

Mr. Donald A. Duff has been appointed City Engineer of Anacortes, Wash., to succeed Mr. S. D. Temple, resigned.

Mr. T. W. Jaycox, M. Am. Soc. C. E., formerly Deputy State Engineer, has been appointed State Engineer of Colorado.

Mr. S. Y. High has been appointed Superintendent of Water-Works of Kansas City, Mo., to succeed Mr. W. G. Goodwin.

Mr. H. S. Jones has been appointed Chief Engineer of the Mobile, Jackson & Kansas City R. R., to succeed Mr. A. N. Bullitt.

Messrs. Cooper and Evans, Engineers and Contractors, have opened a New York office at 220 Broadway, which will be their headquarters hereafter.

Mr. Robert Neiling has been appointed Superintendent of Water-Works of Covington, Ky., succeeding Mr. W. H. Glore, who had held that position since 1875.

Mr. George A. Vollmar, of Ave. R and East 13th St., Brooklyn, N. Y., has been appointed Assistant Engineer in the Aqueduct Commission of New York City.

Mr. Herbert C. Keith, M. Am. Soc. C. E., has removed his consulting engineering office to 1508 Hanover Bank Building, Pine and Nassau Sts., New York City.

Mr. Henry A. Young, Engineer, in the War Department, has been transferred to the Reclamation Service, and will report for duty to Mr. H. N. Savage, Billings, Mont.

Mr. William G. Mather, President of the Cleveland-Cliffs Iron Co., delivered the class day address, May 5, to the graduates of 1905 of the Michigan College of Mines.

Mr. P. A. McCarthy has been reappointed City Engineer of Lufkin, Tex., for the ensuing two years. He has appointed Mr. J. P. Starns his Chief Deputy and Mr. Frank McCarthy, Deputy.

Mr. Paul D. Sargent, of Machias, Me., has been appointed State Road Commissioner of Maine. Mr. Sargent is a graduate of the civil engineering department of the University of Maine.

Mr. J. Francis Le Baron, M. Am. Soc. C. E., has been appointed Chief Engineer of the Great Central of Nicaragua Ry., with headquarters at Port Deitrick, Nicaragua, succeeding Mr. B. W. Homans.

Mr. Jacob H. Whitfield has been elected Superintendent and Treasurer of the Water-Works Department of New Brunswick, to succeed Mr. F. A. Hoffman, whose resignation of that position is to take effect September 1.

Mr. R. F. Kelker, Jr., formerly Assistant Engineer for the Brooklyn Heights R. R., of Brooklyn, N. Y., has become connected with the Goldschmidt Termit Co., as Engineer, and will superintend the street railway department.

Mr. A. C. Shand, Assistant Chief Engineer of the Pennsylvania R. R., has been appointed Assistant Chief Engineer of the West Jersey & Seashore R. R., with office at Philadelphia, succeeding Mr. L. H. Barker, assigned to other duties.

Major James C. Sanford, Corps of Engineers, U. S. A., has been assigned by Acting Secretary of State Adee to represent the United States at the tenth international congress of Internal Maritime Navigation, to be held at Milan, Italy, September 24 and 25.

Mr. Frank E. Vey, of Chicago, has been appointed Engineering Aid in the U. S. Reclamation Service and has been directed to report to Mr. H. N. Savage, at Billings, Mont. Mr. Vey attended the Armour Institute of Technology and has been engaged on track elevation for the C. & W. I. R. R. Co.

Mr. W. G. Schron, formerly in the employ of the Westinghouse Machine Co., as a salesman, has entered the service of the Allis-Chalmers Co. of Milwaukee. He will make his headquarters at their Pittsburg office and will devote his attention to the sale of gas engines, steam engines and steam turbines.

Lu Yao-Ting, a graduate civil engineer of Columbia University, has been appointed Chief Engineer for the construction of a railroad from Hankow, 500 miles up the Yantse-kiang River, and is now in this country studying American methods of railway construction. He will return to China the latter part of this year.

Mr. Thomas Williamson has received a permanent appointment in the U. S. Reclamation Service, and has been directed to remain with Supervising Engineer L. H. Taylor, at Hazen, Nev. Mr. Williamson was graduated with the degree of C. E. from the University of California, and has been engaged with the S. P. R. R. Co.

Mr. Ray Owen, of Wisconsin, Engineering Aid in the U. S. Reclamation Service, has been assigned to duty under the direction of Supervising Engineer H. N. Savage, at Billings, Mont. Mr. Owen had a course of civil engineering at the State University at Madison, Wis., and previous to his employment in the Service in 1902, had experience in topographic work in Ohio, and in telephone service.

Mr. Edward C. Gersbach, of Iowa, has received an appointment as Engineering Aid in . S. Reclamation Service, and has been ordered to report to Mr. H. N. Savage, at Billings, Mont. Mr. Gersbach is a graduate of the Iowa State College with the degree of C. E. and has had practical experience on location and construction work for the I. C. Ry. Co., the C. R. & I. Ry. Co., Chicago Union Transfer Co., and the L. H. & C. T. Ry. Co.

Mr. O. C. Roedder, for the past two years Instructor in the Electrical Department of the Technical University and in the Mechanical Department of the State Technical College, both of which institutions are located at Karlsruhe, Germany, has opened a consulting engineering office at 18 Amalieust, Karlsruhe, where he will act as foreign representative. Mr. Roedder formerly was in the employ of the U. S. Government, and is quite well known as a writer on scientific subjects.

Mr. Brent S. Drane, Engineering Aid in the Hydrographic Branch of the U. S. Geological Survey, has been ordered to continue hydrographic work under Mr. M. R. Hall. Mr. Drane is a graduate of the University of North Carolina and has been engaged in the investigation of flood effects of the floods of 1901 on the river basins of North Carolina and Tennessee, collecting data on the water powers of Southern States, and steam gaging in North Carolina.

Mr. John F. Stevens, M. Am. Soc. C. E., has resigned as Second Vice-President in charge of operation of the Chicago, Rock Island & Pacific R. R., and the St. Louis, Kansas City & Colorado R. R. Mr. Stevens formerly was Chief Engineer, and afterward General Manager of the Great Northern Ry. March 1, 1903, he was appointed Chief Engineer of the Chicago, Rock Island & Pacific, and on August 12, of the same year, he was made Fourth Vice-President. He was chosen Second Vice-President April 5, 1904.

Messrs. Harold D. King and Ralph L. Libby, who have had two years' experience with the U. S. Coast and Geodetic Survey on the trans-continental lines of precise leveling, after a year at the Thayer School of Civil Engineering, of Dartmouth College, have resumed work in the Government Service. Mr. King is placed in charge of primary triangulation in Minnesota along the ninety-eighth meridian; and Mr. Libby has accepted an appointment in the U. S. Geological Survey, Topographical Division. The results of their precise leveling are reported in the Report of U. S. Coast and Geodetic Survey for 1904.

Mr. Henry Cook Boynton, Instructor in Metallurgy and Metallography at Harvard University, was awarded a Carnegie Research Scholarship of $500, at the annual meeting of the Iron and Steel Institute, held in London May 11. Mr. Boynton is the third American to secure this scholarship, two Columbia University men having previously won it. Mr. Boynton graduating from the high school in 1896, entered Harvard University, securing his A. B. degree in 1900, his S. M. degree in 1901 and his S. D. degree in 1904. His thesis for the doctor's degree dealt with the "Relation between the Treatment, Structure and Properties of Steel." Since his graduation Mr. Boynton has devoted much time to research work dealing chiefly with the Metallography of iron and steel and has written several papers on the subject. The present scholarship will make possible a more vigorous prosecution of his investigations in the metallurgical laboratory of Harvard University.

Obituary.

Henry W. Millar, President of Charles Millar & Son Co., of Utica, N. Y., died May 10.

Henry Clay Watts, President of the International Smokeless Powder & Dynamite Co., died May 7, at Camden, N. J.

Samuel Hunt, President of the Detroit Southern R. R., and one of the Trustees of the Cincinnati Southern R. R., died May 15, at his home in Cincinnati, O.

Theodore W. Lord, for 31 years the Brighton Division Superintendent of the Water-Works System of Boston, Mass., died May 10, at his home in Brighton, Mass. He was 69 years old.

Sir Bernhard Samuelson, a well-known authority on railroad rates, died in London, May 10. He was one of the leading English iron masters, and for a number of years was President of the Iron and Steel Institute of Great Britain. He was 85 years old.

Major E. D. T. Myers, President of the Richmond, Fredericksburg & Potomac R. R., died May 12, at Richmond, Va. At the opening of the Civil War Major Myers joined the Engineer Corps of the Confederate States army, and served until April, 1865. Since 1869 he had been connected continuously with the Richmond, Fredericksburg & Potomac, entering as engineer, becoming General Superintendent the next year, then President, the office he had filled since 1889. He was also General Superintendent of the Atlantic Coast Line R. R.

ENGINEERING SOCIETIES.

COMING MEETINGS.

NATIONAL FIRE PROTECTION ASSOCIATION.
May 23 to 25. Annual meeting at New York, N. Y. Secy., W. H. Merrill, Jr.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
June 6, 7, 8, 9, 1905. Annual spring convention at Scranton, Pa. Secy., F. R. Hutton, 12 West 31st St., New York, N. Y.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
June 6 to 9, 1905. Annual convention in New York. Secy., Richard Moldenke, Watchung, N. J.

MASTER CAR BUILDERS' ASSOCIATION.
AMERICAN RAILWAY MASTER MECHANICS' ASSOCIATION.
June 14-21, 1905. Annual meeting at Manhattan Beach, N. Y. Secy., J. W. Taylor, The Rookery, Chicago, Ill.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.
June 19 to 23, 1905. Annual convention at Asheville, N. C. Secy., R. W. Pope, 95 Liberty St., New York, N. Y.

AMERICAN SOCIETY OF CIVIL ENGINEERS.
June 20 to 23. Annual convention at Cleveland, Ohio. Secy., Charles Warren Hunt, 220 West 57th St., New York, N. Y.

PACIFIC COAST ENGINEERING CONGRESS.
June 29 to July 1. At Portland, Oregon. Otto Von Geldern, San Francisco, Cal., or Milnor Roberts, Seattle, Wash.

PACIFIC NORTHWEST SOCIETY OF ENGINEERS.
June 29 to July 1. Annual convention at Portland, Oregon. Secy., Milnor Roberts, Seattle, Wash.

LEAGUE OF AMERICAN MUNICIPALITIES.
August 23 to 25. Annual meeting at Toledo, O. Secy., J. McVicar, Des Moines, Ia.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Sept. 5 to 7. Annual meeting at Montreal, Canada. Secy., Geo. W. Tillson, Brooklyn, N. Y.

ROADMASTERS & MAINTENANCE OF WAY ASSOCIATION.
Sept. 12, 14. Annual meeting, at Niagara Falls, N. Y. Secy., C. E. Jones, C., B. & Q. Ry., Beardstown, Ill.

ENGINEERS' CLUB OF PHILADELPHIA.—At the meeting of May 6 a paper on "Stereoscopic Vision Applied to Surveying," by Mr. E. F. Northrup, was read and briefly discussed. This was followed by a paper entitled "Recent Developments in Expanding Machinery," by Mr. L. D. Lovekin. The next meeting will be held at the club rooms on the evening of May 20, when Mr. F. Herbert Snow will present a paper entitled "The Bacteriological Treatment of Sewage." Secy., W. L. Webb.

ENGINEERS' SOCIETY OF WESTERN PENNSYLVANIA.—Coming meetings of sections of the society are scheduled as follows: Tuesday, May 23, 8 p. m., Structural Section at the society rooms, 410 Penn Ave., Pittsburg, paper on "Cofferdam Construction," by Mr. T. P. Roberts; Tuesday, June 6, 6:30 p. m., Mechanical Section, informal dinner at Atlantic Garden, Pittsburg, followed by a technical session of the section with a paper on "Graphite as a Lubricant," by Mr. D. M. Howe. The past month's meetings were: April 18, general meeting, "Factors That Affect Results in Painting," by Mr. Houston Lowe; April 20, Chemical Section, "Value of Pure Food Legislation," by Mr. A. Gross; April 25, Structural Section, "Concrete-Lined Mine Shafts," by Mr. F. R. Dravo.

PACIFIC COAST ENGINEERING CONGRESS.—An Engineering Congress will be held at the Lewis & Clark Centennial Exhibition at Portland, Oregon, on June 29 to July 1, 1905, to which all engineers, architects and other technical men are especially invited.

A number of papers to be read at the Congress have been promised by members of the Pacific Northwest Society of Engineers, members of the Technical Society of the Pacific Coast, officers of the United States Engineer Corps, and engineers in the Reclamation Service of the Government. These papers are on a variety of engineering subjects of interest to Western engineers, and include such timely subjects as Irrigation, Hydro-electro plants, Reinforced-concrete construction, and River and Harbor improvement. A definite list of titles and authors will be issued shortly.

The program, as now planned, includes meetings on Thursday and Friday, June 29 and 30; an excursion to the Dalles of the Columbia River and the Cascade Locks on Saturday, July 1, under the auspices of the government engineers in charge of the Columbia River Improvement; and an excursion to Cazadero, where a large dam and hydro-electric plant is being installed by the Oregon Water Power & Railway Co. The headquarters of the Congress will be at the American Inn, inside the grounds. Meetings will be held in the parlors of the Inn, which can accommodate 500 persons. Special rates have been secured from the management to visiting engineers. A round trip rate of one and one-third fare has been promised to the Exposition authorities from points within five hundred miles from Portland, and low rates will probably be quoted from other points. For further information, Prof. Milnor Roberts, secretary of the Pacific Northwest Society of Engineers, University Station, Seattle, Wash., or Mr. Otto Von Geldern, secretary of the Technical Society of the Pacific Coast, 89 Flood Building, San Francisco, Cal., may be addressed.

ENGINEERING LITERATURE

Supplement to ENGINEERING NEWS. New York, May 18, 1905.

CONTENTS.

EDITORIAL:
Heck's Steam Engines.—Books for the Water-Works Office.—The Need for a Digest of the Lawrence Sewage Purification Experiments 525
CORRESPONDENCE:
On Engineers' Note Books: W. Newbrough; L. T. Haney; A. B. Aldersen.—A Reply to the Review of Heck's Steam Engines: R. C. E. Heck.—Books on Trees and Woods: Virgil A. Eberly..... 525
REVIEWS:
Four Books on Gas and Steam Engineering. Reviewed by Storm Bull 526
The Secret of the Circle and the Square 527
The Drapers' Company Research Memoirs..... 527
The Mechanical Engineering of Collieries. Reviewed by Francis W. Collins 528
Civic Centers for New York 528
Class Book of Naval Architecture. Reviewed by W. D. Taylor 529
The Field-Practice of Railway Location 529
Mathematics of the Paper Location of a Railway.. 529
Books for the Water-Works Office. By M. N. Baker 530
Electric Railways. Reviewed by Henry H. Norris.. 532
Lives of George and Robert Stevenson..... 532
The Italian in America 532
Long Range Weather Forecasts 532
Experiments on the Flow of Steam. Reviewed by S. L. Kneass 533
Laboratory for Testing Road Materials at Columbia University 533
A Chapter on Brickwork 533
The Sewage Problem 534
Various Engineering Societies 534
Directory of Directors in the City of New York.... 535
Descriptive Geometry for Students. Reviewed by Henry S. Jacoby..... 535
Literary Magazines 536
Publications Received 536

Criticisms from readers, when free from personalities and directly to the point, like the one printed just below, are always welcome. Our correspondent says:

In view of the almost endless mass of "Engineering Literature," it is necessary, both for private use and for class-room work, to make very careful selections. It is right here that the "Supplement" is of immense value, provided that the reviews are carefully written by critics capable of handling the specific subject of the text. Mr. Rockwood's review of Heck's "Steam Engines," in your issue of April 13, does not give much definite information about the subject of the review, and thus stands in sharp contrast with the review of "Two Books on Cement and Concrete," which appears in the same issue of the "Supplement." Insist upon it that a reviewer confine himself to a review of the subject in hand, and not use his privilege for the expression of personal ideas upon the subject matter.

We agree with our correspondent that a review, particularly of a technical book, should convey a good idea of the contents of the book. It seems to us legitimate, however, for a reviewer to express his own ideas on the subject matter in so far as they bear upon the way that matter should be presented, and this is what Mr. Rockwood did. That he might with profit to the reader have given more detailed information about the contents of the book we do not dispute. As to whether or not the reviewer grasped the author's point of view, and as to which of the two is right we leave for our readers to decide, after reading the author's reply to the criticism, printed a little further on.

The average engineer, if he could be located, would be found to possess a very small technical library, and the same is also true of the average water-works superintendent or water-works office. There are gratifying signs that the size of the libraries of both classes of men is increasing. One of these signs is the number of inquiries for lists of special books that reach us. On another page of this supplement we reprint a recent paper on "Books for the Water-Works Office," and a list of about 80 books suggested as suitable for the purpose. A large portion of the books in the list would be equally appropriate for the office of a city engineer or for many engineers in private practice. The total cost of the books would be about $270. Even a small water department or company would be repaid many times over for investing this amount in a good working library, which of course need not follow the list throughout. Distributed over a few years, the acquisition of a library of this extent would not be a heavy drain on a relatively small private income. Some engineers, but we believe they are few, spend as much for technical books in an occasional single year. If the list given in the paper be of no further use it may at least afford amusement for a few minutes in checking off the books one has, would like to have, and thinks he has no use for. We should be interested to see a number of such check lists, and also titles of books that might well be added to the list.

The digest of the evidence presented before the Royal Commission on Sewage Disposal, reviewed elsewhere in this issue, under the title "The Sewage Problem," will bring to the minds of many the great need for a somewhat similar digest of the reports of the Massachusetts State Board of Health on the sewage treatment experiments made at Lawrence. It is true that resumés of the work of individual filters or tanks, and deductions from the experiments, are published from year to year; but these do not begin to serve the same purpose as would a single handbook boiling down the tabular results that have been accumulating since late in 1887, and presenting the deductions that might now be drawn therefrom. In many respects the task suggested could best be done by those in charge of the work, and perhaps most of it ought to be so done; but there would be certain obvious advantages in having critical deductions drawn by independent authorities, particularly by persons familiar with both American and foreign experiments and practice.

CORRESPONDENCE.

On Engineers' Note Books.

Sir: In answer to "Recorder" in your issue of Mar. 16, 1905, I would say he is right in stating there are as many ideas of note books as there are engineers. I will give my own system which is an outgrowth of over 15 years in private office practice, and one which takes in many kinds of work. It probably will not suit all cases, but it may give some help. My books are made for me, in size, 4¼ × 7 ins., and consist of plain quadrille ruled paper, six squares to the inch, 80 leaves, or 160 pages to the book, well bound, no other rulings whatever.

In connection with them I use a common 30-ct. rectangular protractor with the lower edge, however, graduated six spaces to the inch, being the same as the leaves. These I buy, a dozen or so at a time.

When starting a new book I first number all the pages and when using it on a piece of work, I first write the name of the work, who it is for, and any other data including date, on the top of the left-hand page.

Should the work be section levelling, I draw columns with a pencil; should it be a sketch of, say, a mine car, I can make it somewhat to scale with little trouble; if a memorandum of sizes of pipe or an address of a person in connection with the work, it all goes down.

I can write on every line or every other line as I choose, or can make an underground survey and keep my notes entirely by sketching, if I wish. To illustrate, I give here a sample of what Book 48 contains:

Page.
1. Description of land sold by M. V. Morse to G. Anderson. 12-11-'03. (From deed.)
3. Anderson's description of above from letter.
4. Sketch of Evanston No. 1, Reservoir.
5. Notes of Alinement for City Water-Works change.
13. " " lines " " " " " "
33. Sketch standard coal car for K. C. Co.
35. Level notes for freeze out ditch and alinement.
43. Calculations for above.
52. Calculations and stresses and sketches in truss for D. C. Co. coal dump.
76. Grade levels for Evanston, etc., etc.

I make it a rule to make all calculations in these books, even in the office.

Sometimes the writer and one or two assistants are out in the field widely separated on totally different kinds of work. Each has his note book—which receives its proper number when completed. When this happens the contents are card indexed in three or four ways, notably by name of person for whom work was done, by name of work, and, if surveys, by township and range and by name of nearest post-office. This indexing usually takes half an hour.

When going, say, to make a survey at Diamondville, I can turn to this name in the card index at once, find what surveys I have in that vicinity and take what notes I need with me. In no other way could I be sure I had run through all the work I had done in the last ten years at that place, I might forget one or two. This system is also elastic. A client who has considerable work is assigned a book, and when this is filled, another.

This system would not do on, say, Railroad Location, where there is an immense amount of one kind of work to do; there, of course, ruled books are needed.

By the above system I can refer to notes or calculations at any time and do not have to look through the contents of book after book.

My drawings are also card indexed, and I can put my hand on any one of over a thousand inside of 60 seconds.

I have seen the loose-leaf system for notes, but in that case it proved cumbersome and needed a card index as well, because frequently one set of notes should be in two or three places.

The method I use, with modifications, is largely employed in this region by some of the coal companies, deputy mineral surveyors and others.

W. Newbrough, M. Am. Soc. C. E.

Evanston, Wyo., Mar. 21, 1905.

Sir: "Recorder's" article in your issue of March 16 is particularly interesting to me. I agree with him in his plea for a better design of field books.

The objection to having the vertical ruling extend to the top of the page is well taken: at the same time, to eliminate this would necessitate an additional cost, which would prohibit the change.

The indexing is unquestionably a good feature, but I question if the profession would be willing to pay this additional cost. To my mind there are four other good reasons for changing the general form of field books:

(1) It has been my experience that the general form of field books lacks durability, i. e., the binding is of poor quality, and the book is not flat opening.

(2) The ruling should be done with a waterproof ink, and upon the best quality of paper to prevent the colors from running in case the book becomes wet (which usually happens to all field books).

(3) That a protractor graduated at five degrees should be printed upon the right-hand page in a faint color, to facilitate a rapid and accurate sketch, which will show at a glance the cardinal points of the compass, so that any one not acquainted with the field work would be able to decipher the situation.

(4) The book should be reduced in thickness by using a thinner paper, and in width in order that it may be conveniently carried in the hip pocket during the summer months.

I have previously made these suggestions to Wm. G. Johnston & Co., No. 396 Broadway, New York, and they are now publishing a book which appears to be all that could be desired.

L. T. Haney.

220 Broadway, New York City.

Sir: Your issue of March 16, 1905, contains a timely communication from "Recorder," in reference to field books. It occurs to me that it would do no harm, for those of us who feel inclined, to give vent to our feelings through the medium of your valuable publication, and demand a better quality and design, even at a slight increase in cost.

For some years I have had my field books made to order and of course have paid a fancy price for them, as I required a fine quality of paper and first class binding.

Engineer's field books are a valuable reference and should be made in a durable manner in order that they may stand the strain of being shelved in the vault for a few years. Thick coarse covers, poor ruling, and poor paper will I hope soon be "cut out."

Very Respectfully, A. B. Alderson.

West Hartford, Conn., March 18, 1905.

Reply to the Review of Professor Heck's "The Steam Engine and Other Steam Motors."

Sir: The review of a book, entitled "The Steam Engine and Other Steam Motors," which appeared in your issue of April 13, 1905, was made from a point of view so radically different from that of the writer that he feels constrained to ask of your courtesy space for the following brief description of his purpose and of the manner of its development:

In every operation with which the engineer has to do there is a major action of natural forces, which can usually be expressed in terms of simple laws and be predicted from a knowledge of these laws; and besides this

there are certain secondary actions which are frequently obscure in their manner of operation and determinable only by experience under the actual conditions of the particular case. That is, we have a primary, logical theory, based upon the fundamental, simple laws of physics; and a supplementary theory which bridges the gap between the simple ideal operation and the same operation as carried out under actual conditions. In some cases this secondary theory is partly logical; in others the influences at work are so complex and their elements so indeterminable that the best we can hope to do is to give a systematic expression to purely empirical data.

The province of the text-book is to present first the fundamental theory, with a full drill in the applications of the principles involved; and then to develop the secondary theory as far as necessary or practicable, and to indicate the lines along which experience must be accumulated and a sense of proportion cultivated.

Let us take the steam engine as a case in point. The simple theory of any heat engine is concerned only with the impartation of heat to an expansive medium, the conversion of a part of this heat into mechanical work, and the rejection of the residual heat; and in order to isolate these principal operations, the cycle must be thought of as performed in ideal or imaginary physical surroundings. In the actual engine this cycle of operations is greatly modified. A complete theory would enable us to estimate in advance and in detail the magnitude of such actions as the heat-interchanges between the steam and the cylinder walls. That this point will ever be reached seems highly improbable; and the best that we can now do is to make a shrewd guess at the resultant effect of these actions upon the shape of the steam diagram.

In the ordinary piston engine there is thus a wide gap, quantitatively, between the ideal case and the actual. But in the steam turbine, at least to the point where a properly formed jet is delivered from the mouth of a nozzle of the De Laval type, simple theory gives results that will require only minute modification. In other words, friction in the nozzle and secondary actions within the jet are relatively insignificant in effect; and the proper shape for the nozzle can be calculated quite as closely as it can be found by experiment, and at much less expense.

That the pioneers in various branches of engineering had to feel their way, and yet accomplished great things, is no reason why their successors should not have the fullest scientific equipment that is attainable. Whether engineers should have a scientific training is one question; whether a particular treatise will effectively furnish this training is another.

The work under discussion aims to give as much of the science of thermodynamics as is of direct technical utility, properly leaving the further amplification of that rather abstruse subject to special treatises. The description of the engine and of its details will be very fully presented in the second volume.

Yours respectfully,

R. C. H. Heck.

South Bethlehem, Pa., April 17, 1905.

Books on Trees and Woods.

Sir: I wish to obtain a hand-book pertaining to trees and woods; their outward appearance, how to distinguish them, their size, strength, height, characteristics, value, length of life, ability to withstand decay. I desire a book which would meet the needs of a surveyor.

Yours very respectfully,

Virgil A. Eberly, C. E.

Smithville, O., May 1, 1905.

(A serviceable popular book is "Our Native Trees and How to Identity Them," by Harriet L. Keeler (New York, second edition, 1900; $2 net). A more elaborate and more technical work, just published, is "Manual of the Trees of North America," by Prof. Chas. A. Sargent (Boston, 1905; $6). The single book which probably comes nearest meeting all the wants of our inquirer is "The Principle Species of Wood: Their Characteristic Properties," by Prof. Chas. Henry Snow, M. Am. Soc. C. E. New York, 1903; $3.50). This book describes and illustrates the internal as well as the external aspects of many trees or woods, gives height of tree, structural qualities, representative uses, weight of seasoned wood and modulii of elasticity and rupture.—Ed.)

WATER HAMMER.—By O. Simin. Moscow: The Author. Cloth; 6 × 9 ins.; pp. 82; 14 tables; 27 illustrations in the text.

The paper here reprinted was presented by Miss Simin before the American Water-Works Association at its last meeting (St. Louis, Mo., June, 1904). It has been published in the 1904 Proceedings of the Association, but is here available in separate, more easily handled form. As a compact and simple summary of the theory, and the only presentation available to Americans of Prof. Joukovsky's elaborate experimental verification, this paper is necessary to the library of hydraulic and water-works engineers.

Four Books on Gas and Steam Engineering.

Reviewed by Prof. Storm Bull.*

GAS-ENGINE DESIGN.—By Charles Edward Lucke, Ph. D., Mechanical Engineering Department, Columbia University, New York City. New York: D. Van Nostrand Co. Cloth; 6 × 9½ ins.; pp. 254; tables, and 145 figures in the text. $3 net.

STEAM TURBINES.—With an Appendix on Gas Turbines and the Future of Heat Engines. By Dr. A. Stodola, Professor at the Polytechnikum in Zurich. Authorized translation from the second enlarged and revised German edition by Dr. Louis C. Loewenstein, Department of Mechanical Engineering, Lehigh University. New York: D. Van Nostrand Company. Cloth; 6 × 9 ins.; pp. xvi. + 434; 241 figures in the text and 3 lithographic tables. $4.50.

THE TEMPERATURE-ENTROPY DIAGRAM. — By Charles W. Berry, Instructor in Mechanical Engineering in the Massachusetts Institute of Technology. New York: John Wiley & Sons. Cloth; 5 × 7 ins.; pp. xvi + 134; 49 figures in the text.

GAS ENGINES AND PRODUCER GAS PLANTS.—A Practical Treatise Setting Forth the Principles of Gas Engines and Producer Design, the Selection and Installation of an Engine, Conditions of Perfect Operation, Producer Gas Engines and Their Possibilities, the Care of Gas Engines and Producer Gas Plants, with a Chapter on Volatile Hydrocarbon and Oil Engines. By R. E. Mathot, M. E., Member of the Societe des Ingenieurs Civils de France. Translated from Original French Manuscript by Waldemar B. Kaempffert. With a Preface by Dugald Clerk, M. Inst. C. E., F. C. S. New York: The Norman W. Henley Publishing Co. Cloth; 6 × 9 ins.; pp. 314; 152 figures in the text. $2.50.

A WELCOME ADDITION TO GAS-ENGINE LITERATURE.

Dr. Lucke's book is without question a very welcome addition to gas-engine literature in the English language. As the author points out in the preface there is at present no book in our language which treats exclusively of the design of the gas engine, and he might have added that there is found very little with reference to design in any of the books on gas engines in English. Consequently Dr. Lucke has had to go to foreign books and practising engineers for information on this subject. The book is divided into three parts: (1) Power and efficiency, with rules for deciding on the necessary piston displacement; (2) Stresses on the various parts of the engine and also with the various cylinder arrangements as affecting the turning effort and balance; (3) The necessary dimensions of the various parts to resist the stresses with both empirical and theoretical formulae for the computation.

Dr. Lucke bases his computation of the necessary piston displacement on an ideal indicator card and on a diagram factor, which is the ratio between the mean effective pressure formed from the actual indicator card taken from the engine and the m. e. p. found from the ideal card, which of necessity is a different one for every different degree of compression and for the various gases used. Dr. Lucke's idea is that in designing a gas engine the degree of compression is known, also the kind of gas to be used, and that consequently the designer is in position to draw the ideal diagram, or at least to compute the m. e. p. of the ideal diagram, and that he then is to assume a diagram factor according to his judgment and experience. This factor, therefore, is a matter of experience and judgment, and it would seem to the reviewer that his judgment and experience might just as well be used for the construction or assumption of the actual diagram to be expected from the engine from which the m. e. p. might be found by means of the planimeter. As this diagram ought to be drawn later on during the design, in order to take into consideration the inertia effects of the reciprocating parts, and also for the purpose of finding the turning effort on the crank pin, it would seem that the simplest way would be to draw the indicator diagram right at the beginning and to determine the piston displacement from it. However, it is willingly admitted that Dr. Lucke's discussion of this diagram factor is very interesting, especially in its application to the efficiency of the engine.

A curious error has been made by the author on page 3, where it is stated in a formula, and later also in words, that the mechanical efficiency of a gas engine is equal to unity less the fraction of indicated horse-power due to mechanical friction losses and less the fraction of indicated horse-power due to fluid losses and leakage. This last loss, due to fluid losses, has already been taken into account when the indicator card was measured, such losses being shown on the indicator card either by a too high exhaust pressure or too low suction pressure or both. When measuring the indicator card by the planimeter the corresponding areas are as it were automatically subtracted from the total, and as Dr. Lucke defines the mechanical efficiency as the ratio between the brake horse-power and the indicated horse-power it is impossible to see how the fluid losses can effect the mechanical efficiency as a separate factor in the manner given above. Curiously enough these losses affect the economy of the engine, which, however, is a very different thing from the mechanical efficiency.

The second part of the book treats principally of the effect of the reciprocating parts and the turning effort on the crank pin. The discussion is very interesting and complete, and the very large number of indicator diagrams, with corresponding diagrams of turning efforts, both corrected for inertia effects, are very instructive. However, the reviewer cannot help finding a little fault with the fact that Dr. Lucke prefers the analytical method for finding the tangential forces at the crank pin to the graphical method. He states that the first method is both quicker and more accurate. Having had a very large experience in this direction the reviewer begs to say that he is of the opposite opinion, and in addition that the graphical method is very much clearer than the other. It also seems rather unfortunate that the author uses a different horizontal scale for the indicator diagram than for the diagram of turning effort. In the opinion of the reviewer the base of this latter diagram ought to be twice the length of the crank pin circle to the same scale as the base of the indicator diagram, a four-stroke cycle engine being assumed.

The third part of the book treats of the dimensions of the parts of the engine; it seems in general to be very satisfactory. As the literature in English on this subject is very meager the author must of necessity have collected a large amount of material, both from his own experience and from the literature in foreign languages. Both the rational and empirical formulae given in the book seem to be adequate, and the discussions preceding them are clear and to the point. As the author does not draw an indicator card such as the engine which is to be designed, is supposed to give, he cannot construct a turning effort diagram, and consequently he cannot find graphically the excess or deficiency in kinetic energy which the flywheel must take care of, but he must content himself with assuming a factor which expresses the ratio between this excess and the work done by the engine during a cycle. This factor depends necessarily on a great many circumstances; first of all, on the shape of the indicator card, on the length of the connecting rod, on the number of cylinders, and also on whether it be a two or four stroke cycle engine. The uncertainty in selecting the correct factor will, therefore, be considerable, and this is an additional reason why it would seem to be a better method to start with an indicator card such as can be reasonably expected from an engine of the kind which is to be designed.

The very large number of tables contained in the book, partly for facilitating computations and partly to help in selecting the dimensions of various parts, will certainly prove very useful. They represent much work on the part of the author.

Unlike Güldner's book,* this work does not contain any illustrations which will help in giving the proper shape to the various parts, nor are there any illustrations provided with dimensions. Presumably the author did not intend to give such a scope to the book, as it certainly would have doubled its size. It will, therefore, be necessary for the designer to consult the current technical literature or Güldner's book to find examples from practice in order to follow Dr. Lucke's book. But it is a very notable addition to the literature on the gas engine.

It is excellently gotten up; the illustrations are good, and notwithstanding the difficulties in the way there seem to be very few misprints.

*Professor of Mechanical Engineering, University of Wisconsin.

*Treatise on Gas, Gasoline and Oil Engines (in German), reviewed by Professor Bull in this Supplement for May 14, 1903.—Ed.

A TRANSLATION OF STODOLA'S DAMPFTURBINEN.

Every American engineer ought to rejoice that Dr. Stodola's book has been translated into English. As this reviewer already has pointed out in his review of the original German edition (Jan. 14, 1904), this work is by far the best of all relating to this subject in any language. The translation now makes it accessible to a great many engineers who could not make use of the original.

The translation of a book like this requires a very large amount of work, as all the formulæ and tables based on metrical units must be entirely recalculated for the English units and Stodola's book contains a very large number of these tables. How these computations have been made it is, of course, impossible to judge except by actual use of the tables; but from a fairly thorough examination it would seem that the work has been very well done. The same cannot be said of the translation itself. Sometimes the translator has attempted to translate the German directly into English, with the inevitable result of getting a very poor English, which it is very difficult to understand in a great many places; at other times a freer translation has been made, but the attempt has frequently resulted in a false rendering of the German. It is unnecessary to point out examples of clumsy English, as anybody upon opening the book at any place will find all the proof required for sustaining the above statements. It is perhaps desirable to give a few examples of the false rendering of the German. On page 108, the 11th line from the bottom, and on page 113, the 7th line from the top the words "corresponding to" are supposed to be the translation of "Zuzüglich." This word, however, means "in addition to," and the meaning of both sentences is absolutely changed because of this error. On page 115 the first line reads: "so that the increase at c corresponds to the loss towards the end." The German is: "dass der Steigerung von c. entsprechend der Verlust gegen das Ende ebenfalls rascher anwächst." The correct translation of this sentence is: "so that corresponding to the increase of c, the loss will also grow more rapidly towards the end." On page 118, 7th line from the top, a sentence reads: "We must now compare from the entropy diagram by measuring the vertically sectioned area which was used to get the line Rx with the value that has already been obtained." A correct translation of the German is: "By measuring the vertically sectioned areas of the entropy diagram one would obtain a line Rx which could be compared with the line Rx already obtained." The next following sentence in the German edition has been entirely omitted: "But the circumstance that Rx is very little different from the line Hx, as is shown in Fig. 59, shows that we are not very far from having the two curves Rx coincide." A few lines below the word "stetig" is translated into "constant," it should be continuous.

On page 119, 3d line from the bottom, the word "Annäherung" is translated into "Assumption," it should be "approximation." On page 120, 7th line from the bottom, the word "omitted" is used; the German word is "preisgegeben," it should be translated into "neglected."

The foregoing are not the most glaring examples of wrong rendering of the German, but have been chosen becaure they are short enough for presentation here.

A number of misprints of the German edition have been faithfully reproduced in this translation. Attention may in this connection be called to the third equation from the bottom on page 41, which equation should read

$$L' = L_1' + L_2' = \frac{u^{13}}{g}$$

and not

$$L' = L_1' = L_2' = \frac{u^{13}}{2g}$$

as found in both the original and the translation. On page 94, line 14 from the top, the last letter is D_r, it should be D_n, but in the original D'_r is found. Other examples could be quoted, but these must suffice. In conclusion the reviewer desires to state that the usefulness of the book has been considerably reduced by the faulty translation. The original is in itself quite difficult to understand, principally because of the brevity of both discussions and deductions, and the task of the translator has consequently been very difficult. This is perhaps the explanation of the various errors mentioned above.

THE TEMPERATURE-ENTROPY DIAGRAM.

The use of the temperature-entropy diagram has of late become very common in all kinds of investigations of the various heat engines. On the other hand, a number of the most widely used treatises on thermodynamics and on the steam engine contain very little information on the subject, and it is therefore but natural that books should be published which attempt to supply this want. Mr. Berry's book is of this kind; it presupposes a knowledge of thermodynamics, also of the working and behavior of the various kinds of heat engines, and it is therefore supplementary to such books as Peabody's "Thermodynamics of the Steam Engine," in which the temperature-entropy diagram is hardly mentioned. The book is very clearly written and, although it does not furnish any better definition of entropy, that intangible and obscure property of all bodies, than we have had before, yet by the very large number of applications of the temperature-entropy diagram contained in the volume, it cannot help getting clearer and more tangible in the mind of anyone studying the book. The reviewer, who has taught thermodynamics for a good many years, is of the opinion that a good dose of this book would be a very healthy food for students of thermodynamics and of heat engines.

The book is divided into twelve chapters. The first chapter treats of reversible processes and cycles, and in the following eleven chapters the T φ diagram is applied to the following processes and engines: perfect gases, saturated steam, superheated vapors, the flow of fluids, hot-air engines, gas engines, the non-conducting steam engine, multiple-fluid engines, the liquefaction of gases, compressors and refrigeration, the actual steam-engine cycle as recorded by the indicator.

As will be seen, the author has covered quite an extensive field, and on the whole he has done it very well. It is probable, however, that the book might have been improved if he had spent a little more time and space on the actual steam engine, the chapter on this subject covering only 18 pages. What there is on the subject is very good; but why not, for instance, have extended the application of the T φ diagram to the compound and multiple expansion engines? Some examples of indicator cards transformed to T φ plane for both simple and compound engines would certainly have added to the usefulness of the book. But notwithstanding this need of expansion, the book deserves a wide circulation among all engineers who are interested in the study of heat engines.

MATHOT'S FRENCH WORK ON GAS ENGINES RENDERED IN ENGLISH.

In a previous issue (Feb. 16, 1905) the reviewer called attention to this excellent book in the original French. The engineering profession is to be congratulated on the fact that it now has become accessible to all through this translation. From a fairly careful comparison of the original French with this English translation the reviewer has found but few changes which the author had made in the manuscript which the translator has used, and also that the translation has been very well made. The original is very clearly written and the translator has succeeded in preserving this clearness. The illustrations are excellent, the print and paper good and the price moderate for the size of the book. The preface of Mr. Dugald Clerk, probably the best authority on the subject in Great Britain, and which appears for the first time in the translation, is highly complimentary in its nature, and as a few sentences of this preface express the opinion of the reviewer better than he could formulate them himself, they are reproduced here:

> I have read this book with much interest and pleasure, and I consider that it deals effectively and fully with all the principal detail points in the installation, operation, and testing of these engines. I know of no work which has gone so fully into the details of gas engine installation and up-keep.

The title page gives a good resumé of the contents of the book, and it need only be stated here that it does not treat of the theory nor of the design of the gas engine or producer.

With the rapidly increasing importance of the gas engine and of the gas producer, the book will find a large sale.

An Abandoned Problem.

THE SECRET OF THE CIRCLE AND THE SQUARE.—By Jeremy C. Willmon, Los Angeles, Cal. Published by the Author. Cloth; 5 × 7 ins.; pp. 30, including 7 full-page plates.

Eight geometrical problems and their solutions are presented by the author. None have any practical interest, and four of them have no theoretical interest or merit. The other four center around the problem of drawing a straight line equal to the circumference of a given circle. The solution of this problem here given involves an infinite number of steps, and is, therefore, not a geometrical solution, strictly speaking; such as it is, however, it is exact. From this problem, of course, follows the problem of "squaring the circle" by everyday methods.

DRAPERS' COMPANY RESEARCH MEMOIRS.—Technical Series, Memoirs I. to III. Issued by the Department of Applied Mathematics, University College, University of London. London: Dulau & Co. Paper; 9 × 12 ins. I.—On the Theory of the Stresses in Crane and Coupling Hooks, with Experimental Comparison with Existing Theory; by E. S. Andrews, with some assistance from Prof. Karl Pearson. Pp. 27; 13 diagrams. 3s. II.—On some Disregarded Points in the Stability of Masonry Dams; by L. W. Atcherley, with some assistance from Prof. Karl Pearson. Pp. 27; illustration in the text and 3 plates. 3s. 6d. III.—On the Graphics of Metal Arches, with special reference to the Relative Strength of Two-Pivoted, Three-Pivoted and Built-In Metal Arches; by L. W. Atcherley and Prof. Karl Pearson. Pp. 53; 3 plates. 5s.

Two years ago the Worshipful Company of Drapers of London presented £1,000 to the University of London to further research work. This fund was turned over to the Department of Applied Mathematics, to assist in its "statistical work and higher teaching." The present three memoirs represent work done with the assistance of this grant. The subjects of the three papers are, briefly, the following: In Memoir I., the stresses in the dangerous section of a hook, such as a crane or coupling hook, are expressed in mathematical form. The influence of the curvature of the hook is taken account of, which is by no means new, and in addition the transverse compression of the material is considered. Experiments made on several hooks to determine the load at true elastic limit are cited, and the results are analyzed by the derived formula in comparison with a straight-beam formula, not with the curved-beam formula. The straight-beam formula results, as may be expected, in very discordant values for the elastic limit of the metal, while the derived formula gives quite constant values. In Memoir II. a mathematical discussion of stresses in homogeneous dams of pure gravity type is presented. Attention is called to the assumptions necessary as to distribution of shear at base, but the author shows that under any assumption there are likely to be dangerous stresses in vertical sections near the toe—stresses tending to break off the toe. An illustrative experiment on a model dam is advanced to prove that the stresses in the vertical sections are often more dangerous than those in horizontal sections. Memoir III. deals with metal arch solid rib bridges, by a cumbrous theoretical development leading to graphical processes. Stresses, due to loads and temperature, and deflections are examined. The processes are applied to a rib arch having the outlines of the Pont Alexander III. in Paris, in three cases, respectively, three-hinged, two-hinged and fixed-end. The authors conclude that the fixed-end arch is just as good in the matter of stresses, and slightly better than the other two in the matter of deflections. No result or conclusion of general value is reached, and the expressed conclusions are only such as may easily be (and have frequently been) derived from *a priori* consideration.

Another Treatise on the Mechanical Engineering of Collieries.

Reviewed by Francis W. Collins,* M. Am. Inst. Min. E.

THE MECHANICAL ENGINEERING OF COLLIERIES.—By T. Campbell Futers. Vol. I: (1) Boring. (2) Shaft Sinking. (3) Surface Arrangements. (4) Shafts and Headgears. London: The Chichester Press. Paper; 7½ × 9¾ ins.; pp. 128; 294 illustrations. 7s. 6d. $3 in America.

Percy's "The Mechanical Engineering of Collieries" ranks as the pioneer work on this broad subject, and now Mr. T. Campbell Futers aims to present a modern and complete work on the same subject and under the same title.

The material comprising this volume of Mr. Futers's work first appeared serially in the "Colliery Guardian," of London. It covers (1) Boring, (2) Shaft Sinking, (3) Surface Arrangements, (4) Shafts and Headgears; while for the second volume is reserved Winding, Heapsteads, Screening and Washing. Any one of the enumerated subjects when fully treated would exhaust the whole 128 pages devoted to the five subjects discussed in the present volume. The 294 diagrams and illustrations are excellent; they are aptly chosen and, in the main, well reproduced. No attempt has been made to aid the reader in finding any subject for there are no paragraph headings or other typographical indications of where one subject ends and another is taken in hand.

Chapter I. considers boring. Nineteen cuts and the greater part of 28 pages of text are given to diamond drills, steam, electric and hand-driven, all of them being of American manufacture. There are detailed descriptions of hydraulic and differential feeds and also feeds used in hand drills. No comparison is made between the steam, electric and hand drills: nothing is said as to sizes of drills, costs or rates of drilling.

Rope boring is limited to a brief description and some cuts of the English system of Mather & Platt. In this system the tool is set with removable chisels, or cutters, and is operated in a manner similar to that in the American oil-well method, but not a word is said of this latter or other important methods of rope boring.

Next to the diamond drill, in the point of space occupied, is the subject of hand boring. The author states that hand boring is most generally employed for ordinary colliery purposes because of simple arrangements and the ease of repairing the tools by colliery mechanics, despite being slower than the diamond drill and not giving such good results. He says that there is no difficulty in using hand boring to depths of 100 fathoms (600 ft.) at a cost which probably compares very favorably with that of other systems. Cuts and diagrams well illustrate hand-boring arrangements and tools.

Two type of hand auger drills are figured and briefly described. One is for boring against old workings that may be under heavy water or gas pressure; the other is designed to avoid choking the drill with debris, when boring long holes, by means of hollow rods and a stream of water.

The staying of pipes or tubes when putting bore holes down under water is illustrated by the method used for the Prince Edward Island-New Brunswick tunnel.

The reader is referred to Callon's Lectures on Mining for descriptions of many other tools and appliances used in boring. The author considers tools such as those for withdrawing broken rods, pipe clamps, etc., etc., unnecessary of description, and he gives an extremely short "Bibliography" in conclusion.

In opening Chapter II., on Shaft Sinking, the respective advantages and disadvantages of circular and of rectangular shafts are briefly set forth. The author favors the latter form of shaft when considering the two from a mechanical engineering standpoint. Temporary headgears are illustrated and described in a general way. A pair of balanced folding doors for the landing platform of a temporary headframe is figured, as is a particular make of kibble (sinking bucket). There are good diagrams of a combined sinking and walling platform used to permit simultaneous sinking and lining of circular shafts.

A patented sinking or boring frame for circular shafts is described next. Essentially it is a multi-armed steel frame on which are mounted either machine or rotary drills. The whole affair is lowered by cable and engine into the shaft for a drilling shift, braced in position and a full round of holes drilled. The rotary drills, driven by flexible shafts, may be operated from a central electric or a petrol motor, as well as from air motors for each drill.

The handling of water by hoisting and by pumping is discussed at some length, with notable examples of the disposing of large quantities of water. There are a number of diagrams and illustrations, including cuts of Deane, Pulsometer and Denaby pumps.

Sinking or crab engines, winches and temporary foundations, for the former, are given three pages of text and several diagrams. Under sinking, the support and lining of the shaft are taken up: cribs, tubbing, interlocking channel bar piling, freezing, the Kind-Chaudron and the Gebhardt and Koenig freezing methods. A very short bibliography closes this chapter.

Chapter III., Surface Arrangements, consists of six pages and one full-page diagram. The author says:

> In laying out the surface arrangements of a colliery, it is impossible to lay down any hard and fast rules, as so much depends upon circumstances, local conditions, and the quality of coal being worked. It does not depend so much upon the output—except in so far as with a larger output the arrangements would be designed on a larger scale—as, whether the output be large or small, somewhat similar surface arrangements are required. There will be two shafts, winding engine, ventilating van, pumping machinery, boilers, heapstead, screening and picking plant, electric lighting, cabins and workshops, railways and possibly sidings, washing plant, locomotive sheds, etc., all to arrange for; and to do this, so that the coal may be quickly and easily handled from the pit's mouth into the railway wagons, with the least amount of labor and smallest expenditure of capital, requires much careful consideration.

The concluding chapter is on shafts and headgears, and it is the best part of the book. The arrangement of compartments and cages in shafts, using the small, English multi-deck type of cage, is illustrated by working out an example and by diagrams.

The author gives the advantages of wire rope guides as: (1) Lessened first cost; (2) easier fitted up and secured; (3) the shaft is clear of buntons or other fixtures, which are necessary with rigid guides; and (4) freedom to expand or contract. The disadvantages are: (1) Danger of collision; (2) larger diameter of shaft with consequent greater cost of sinking for the same output. He summarizes the guide question by saying:

> If the chaft is large and clear, and the cages can be kept well apart, with at least a distance of 18 ins. between them, and 12 ins. between the corners of the cage and the shaft side, use rope guides, but if the shaft need not be large for the purpose of ventilation, then keep the diameter as small as possible and use rigid guides. The effectiveness of any form of guide is directly proportional to the distance from the winding rope or point of suspension to the guide, and consequently in designing any arrangement of guides they should be kept as far from the winding rope as possible.

The attachment, weighting and size of guide ropes is discussed next. Then rigid guides, both steel and wood, are treated in a similar manner.

In considering headframes the author say:

> Headgears or pulley frames may be of wood, iron or steel, or columns of masonry or a combination of both. * * * It is difficult sometimes, however, to procure long lengths of pitch pine timber from 60 ft. to 80 ft. of large enough dimensions, absolutely straight, and free from sap, knots or other defects, whilst steel frames have no limit to their dimensions. It is really a question of cost against durability, and the difference in the price between a set of wood pulley frames and a set of steel ones invested for a period of thirty to fifty years—which will be about the life of wood frames—will probably more than compensate for any want of durability. For very large collieries, however, a steel structure is practically imperative. The purposes of the headgear is two-fold—first, to support the pulleys upon which are carried the winding ropes, and, secondly, to guide the cages from the surface or ground level, that of the discharging—or, as commonly expressed "flat sheet"—level, and is really a continuation of the shaft above ground. The headgear may be designed so that the pulley frames are independent of the cage framing, which is probably the best way, or the two may be combined so that the cage frames also support the pulleys. The former is most generally adopted in this country, but abroad the latter method appears to be most in favor.

The designing of wooden and steel [illegible]ears is taken up at greater length and detail [illegible] any other subject treated. The author gives [illegible]graphic solution for the resultant stresses on a [illegible] carrying winding ropes only—contrary to [illegible] American practice of combining pulley and [illegible]ames. Very long backstays are employed, [illegible] the wooden and steel types, they being inte[illegible] to take stresses that in American practice are [illegible] as signed to front members and str[illegible]. These greater stresses on backstays requi[illegible] crawler cross-sections, and also the lengthe[illegible] of the backstays means a further increase of [illegible]rial to prevent failure from flexure. In desi[illegible] these structures it should be kept in mind [illegible] the stresses on the rope and frame due to t[illegible]dinary loading are greatly augmented when [illegible]es are started from rest (see Kent's "Mechan[illegible] Engineers' Pocket-Book," p. 908). Appa[illegible]y this starting shock is not considered by the [illegible]hor, in which case his example of the design of [illegible]rame is open to further criticism.

There are a number of good diagrams of wooden and steel frames and their details. An automatic shaft gate and a 10-ft. and a 20-ft. sheave or pulley are also shown. Winding in up[illegible] shafts are spoken of.

On page 89, in the first column of the table, there is a typographical error, "Diagram" being used for "Diameter."

In the event of the author's aiming to make his volume complete as regards English practice, he perhaps has succeeded; but as for making it complete, in that he covers the best or most prominent practice wherever found, he has not. The subjects are treated in too much of a general way when touched on at all. As a book for a semi-professional man, or to supplement a course of lectures, the present volume would serve excellently; for it is well enough illustrated, so far as it goes, to negative some of the criticism made of the rather narrow treatment of its subjects.

CIVIC CENTERS FOR NEW YORK.—Report of the Committee on Civic Centers, Bulletin No. 15, Municipal Art Society of New York. By Gabrielle Stewart Mulliner, Secretary. New York: The Society (37 W. 34th St.). Paper; 5½ × 8½ ins.; pp. 14; plates.

In these few pages of text and with the aid of diagrams, the author presents a strong argument for grouping public buildings. The improvement of New York, and particularly the city hall section of Manhattan, is the object directly in view, but the general argument is applicable to all cities. The following definition may be of service to some of our readers:

> The term "civic center" has been accepted by students of civic improvement to include the grouping of public buildings around a park or open space or plaza, so that to the advantages of light and air is added the length of vision which enhances architectural beauty, while there are also brought into closer relation those buildings which, through their use by the public become the center of civic life. That a grouping of public buildings makes a city more beautiful does not need argument. The cities of Europe, which are in their main features known to almost all educated Americans either by personal visit or from photographs, are examples of the beauty to be obtained by a regard for placing buildings in proper relation to each other.

MOSQUITOS OR CULICIDAE OF NEW YORK STATE.—Bulletin 79, Entomology 22, New York State Museum. Ephraim Porter Felt, State Entomologist. Albany, N. Y.: New York State Education Department. Paper; 5¾ × 9 ins.; pp. 241 to 400; 57 plates, one folding table, and 113 text illustrations. 40 cts.

The recognition, within the past few years, of mosquitos as the agent in the spread of malaria and yellow fever has led to a number of recent publications on that insect. The present volume treats briefly of mosquitos as carriers of disease, and of the life history and enemies of the pest. It then describes the mosquito and its various species in detail, with the aid of numerous illustrations.

MASSACHUSETTS HIGHWAY COMMISSION.—Report for 1904. Boston, Mass.; Pub. Doc. Cloth; 6 × 9 ins.; pp. 99; many tables and one folding map.

The twelfth report of this commission follows the lines of earlier reports. Some information on the cost of tree planting, the success of using willows to protect the slopes of a cut through clay and contract prices for the year are given. A map of the State shows roads built and petitioned for to the close of 1904.

*352 W. 123d St.

A British Text-Book of Naval Architecture.

Reviewed by D. W. Taylor.*

A COMPLETE CLASS-BOOK OF NAVAL ARCHITECTURE—Practical, Laying Off, Theoretical. By W. J. Lovett, Lecturer on Naval Architecture at the Belfast Municipal Technical Institute. With Numerous Illustrations and Almost 200 Fully Worked-out Answers to Recent Board of Education Examination Questions. London, New York and Bombay: Longmans, Green & Co. Cloth; 5½ × 8¾ ins.; pp. 283. 7s. 6d., net; American price, $2.50.

This work is intended primarily for British students attending technical classes, particularly those preparing themselves for the examinations of the Board of Education. In Great Britain such examinations, somewhat similar to our Civil Service examinations, are held at intervals all over the country. In naval architecture there are several stages of these examinations, and students passing a stage successfully are given certificates of proficiency.

Mr. Lovett in 280 octavo pages covers the whole field of naval architecture, theoretical and practical. Twenty pages are given up to the naval architecture syllabus, sample questions, etc., of the Board of Education. About a third of the book is devoted to questions and fully worked out answers. Moreover, there are no separate plates, the figures used, 173 in number, being all incorporated in the text. Although a majority of these figures are illustrative sketches, it will be evident that the space in the book available for the text proper is not adequate to allow any part of the subject to be covered in great detail. The author, however, has not shrunk from his task and has made a commendable effort to say something, however brief, upon every aspect of naval architecture and shipbuilding, as applied to merchant work. The special features of man-of war work are not covered. In fact, the author points out that "the science of shipbuilding has to do about 90% with cargo-carrying vessels. Boats are built to carry. Passenger boats are a very small percentage of the world's merchant navy."

The work begins with a brief summary of various simple mathematical principles and formulae and then goes on to methods for the usual ship calculations, such as areas, centers of gravity, displacements, centers of buoyancy, tons per inch, etc. Calculations of weights are then touched upon and information given as to the weights of various classes of material and the space required for stowage of various kinds of cargo. Statical stability, questions of center of gravity and trim and launching calculations are next discussed. After going into the methods of determining the strength of and strain upon vessels, information is given regarding the British rules for determining tonnage and the rules and requirements governing freeboard. Very brief treatments are given to the subjects of corrosion and fouling, rudders, horse-power and propellers. The theoretical portion of the work is concluded with the enumeration and definition of the curves and coefficients used in ordinary calculations and a number of approximate formulae.

Then, after discussing the subject of laying off, two chapters are devoted to the question of scantlings of vessels and the rules of Lloyd's and the British Corporation, the application of the rules of the two societies to the principal structural parts of merchant vessels being briefly explained.

Finally, under the head of "The Ship in Detail," 49 pages are devoted to shipbuilding, from preparing the berth to such details as pumping and draining and watertight doors.

The questions and answers at the end of each chapter, which are a conspicuous feature of the book, do not refer very closely to the text but in numerous cases cover ground not covered by it and thus supplement the very brief treatment of many subjects.

The book is thoroughly original, the author apparently making but little use of previous works on naval architecture. In some respects this is a source of weakness. Thus, a statement on page 225 that "pneumatic and electric riveters have been tried, but their success in ship riveting has been only moderate," may be correct so far as the author's experience goes, but certainly is not correct as a general statement. In the United States pneumatic riveters have entirely supplanted hand riveting with thorough success.

There are a number of blemishes scattered through the volume. To American eyes the expression, "sheering force," looks peculiar, but the author never uses the word "shearing," although "sheering" as applied to strength is believed to be as obsolete in England as in this country. On page 70, when discussing the moment of inertia of a water plane, a purely geometrical quantity, the author says "Inertia is that property which all bodies have of resisting change, either of rest or motion. The moment of inertia is the measure of this resistance." On page 114 it is stated that the sliding ways in launching should not have a pressure of more than two tons "per square inch." "Per square foot" is meant. In Chapter IV. is tabulated much valuable information on the stowage requirements for various kinds of cargo. Although we find in this chapter a statement of the cubic feet per ton for nine different kinds of oil, the author nowhere gives any information regarding the stowage space required for any kind of coal.

The book is peculiarly weak as regards the question of materials. A very inadequate description of the methods of production of iron and steel covers the action of the blast furnace in one line on page 216 as follows: "The ore after quarrying is melted and run into molds, giving pig iron." Cast steel is treated of only in a six-line answer to a question on page 251, which opens with a statement that cast steel "is obtained from pig iron by adding carbon, silicon, etc."

In contrast to its treatment of materials, the treatment of the ordinary elementary ship calculations is excellent and the book will undoubtedly be of value to students attending classes who can obtain from their instructors amplifications of the very brief treatments of many subjects. In this country its field as a text-book will necessarily be comparatively limited, and as a reference book its treatment of the various subjects, except elementary ship calculations, is inadequate.

*Naval Constructor, U. S. N., Navy Yard, Washington, D. C.

Railway Location.

THE FIELD PRACTICE OF RAILWAY LOCATION.—By Willard Beahan, B. C. E., Division Engineer, Chicago & Northwestern Railway, Late Chief of Locating Parties on Gould's Southwestern Systems of Railroads. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 252; tables, plates and figures in the text. $3.

This work of Mr. Beahan fills a gap in engineering literature; particularly as the author enters into a detail of the practical features of railway location as developed in the Great West in the last thirty years. Within these years more miles of railways have been built than in any equal period in any other part of the world. And the varied topographical and economic features of that section are such that the locating engineers were compelled to revise and simplify older methods, and to devise new ones to meet existing and controlling conditions. That their work was generally well done is proven by the test of time; but we also know that the resultant experience was in many cases dearly bought, and that the final and approved practice was a development and an outcome of this experience. As the author well says in his preface, the fact that so little of this experience and practice has been published and thus made accessible to the present generation of engineers is due to several reasons. In the first place, those responsible for all this truly great work were very busy, self-sacrificing men; too much engaged in solving the hard problems daily presented to do much in the way of acquainting the world with the detail of their doings. To a large extent these men were pushing civilization into a wholly new country; and, aside from the difficult engineering conditions that had to be handled, were those of subsistence, transportation, and at times defence against Indian enemies. If we couple with this the other fact that their very isolation in a large measure unfitted them for later literary effort, we have a sufficient reason for a dearth of literature at their hands. For these reasons the profession of engineering is indebted to the author for his effort to here permanently record the experience gained and now well tested.

The economic theory of railway location has been exhaustively treated by the late Mr. A. M. Wellington; and though his book is now nearly twenty years old, it is still an authority. Based largely upon this established theory, Mr. Beahan has issued a work giving the practice of location.

The author starts out with an assumption that few, if any, will dispute. And that is, that the successful locating engineer must be a good topographer and also a good railway engineer, experienced in both the construction of railways and in their maintenance of way. Lacking these qualifications, the engineer cannot do his best work in location. Without entering into too much detail, the sequence of Mr. Beahan's work is taken up as follows:

The first chapter is devoted to the character of the proposed railway; the nature and volume of its traffic as nearly as these can be ascertained; the effect upon it of systems of railways and of branch lines; the cost of construction, etc. There is much good material here, and it is only to be regretted that some of it was not presented at further length. The note on branch-line practice is particularly good, and the author clearly points out what many young engineers misunderstand: that in the location of such branch lines it is sometimes profitable to sacrifice mere engineering considerations to the commercial demands. In other words, as the author puts it, "Strike the main line as quickly as possible, without increasing cost to save distance"; otherwise cost of maintenance and some train expenses are being duplicated. Succeeding chapters deal with the methods of reconnaissance, and the organization, subsistence and equipment of the parties. And here again we have much of that dearly bought but very valuable experience of the earlier men. The chapter on reconnaissance is an expecially valuable one, as it deals with the topography as affecting the route, and lays especial stress upon the drainage of the country, used as a framework on which to hang the located line.

Chapter V.—on geology in its relations to topography—is written by Mr. John C. Branner, Ph. D., Vice-President and Professor of Geology in the Leland Stanford Jr. University. The chapter points out in a striking manner the great value of a close study of the general laws governing the origin and development of topographic forms. And the first of these laws is that topography is not to be ascribed, as a rule, to violent cataclysmic disturbances, but it should rather be regarded as the resultant of the operations of eroding agencies, and the resistance of the rocks, the time of their exposure, the initial appearance of the surface, and the orographic changes suffered. As Prof. Branner puts it—To set a man at work on topography who knows nothing of geology is very like having some one perform a surgical operation who knows nothing of anatomy. The writer then proceeds to treat of rocks as the material of topography, the origin of different kinds of rocks, the structural changes in beds of rocks, the constructive and destructive agencies, and the forms they produce, etc.

The next two chapters treat of those elementary principles of locomotive design, proportion and capacity and train resistance which the locating engineer should know before he can intelligently handle his grade and curve problems. The chapter on train resistance and the elements that should control in the final location is clear and detailed, and is one of the most useful in the book. The last chapter deals with the records and the cost of surveys, the form of notes, the scale of maps and profiles, and it gives considerable data upon the actual cost of surveys in the Western country, this cost ranging from $50 to $150 per mile of located line, according to country traversed. The book has a full index, and in its contents well covers a new field in engineering literature.

MATHEMATICS OF THE PAPER LOCATION OF A RAILROAD.—By J. C. L. Fish, Assoc. M. Am. Soc. C. E., Associate Professor of Civil Engineering, Leland Stanford, Jr., University, Palo Alto, Cal. (Reprinted from Engineering News, March 16, 1905.) New York: M. C. Clark. Stiff paper; 4½ × 7½ ins.; pp. 18; two figures in the text. 25 cts.

The object of this pamphlet is to present the steps involved in preparing a set of mathematic-

ally correct alinement notes by which to put upon the ground any railroad line located on paper. The author has used the methods described for instructing his classes in railway location, and other instructors may likewise find them of value. Many practicing engineers rely only on scaling from the map, but with the increasing popularity of paper locations it would appear that more accurate methods will oftener be used in the future. The author describes in detail accurate methods for paper location work.

Books for the Water-Works Office.*

Not many years ago the library of a water-works office began and ended, if indeed it began at all, with Fanning's "Water Supply." That monumental work was for some years practically the only American book designed for water-works engineers and superintendents and was quite generally thought to meet all their needs. Since Fanning's treatise appeared many other books specifically designed for water-works men have been published. Meanwhile the scope and magnitude of the duties of water-works officials have so enlarged that many books outside the specific field of water-works literature are needed for a well-equipped water-works office. Certain as is this need, how frequently is it recognized and supplied? In how many water-works offices would there be found at this minute a dozen good books on water-works and even one on any of the numerous closely allied topics?

It is easy enough to explain, but the explanations do not wholly excuse, the smallness of the libraries of most water-works offices. Some of the reasons why more books are not in use are: (1) Lack of appropriations for the purchase of books; (2) lack of interest in books because of the too frequently short tenure of office; and (3), most valid of all explanations, the almost absolute lack of books on maintenance and operation. A little zeal for a water-works library would, in most instances, secure at least a small yearly sum for the purchase of books. The frequent short tenure of office makes the need of a library all the greater. The lack of books on maintenance and operation might be overcome if some of the many capable and experienced superintendents, secretaries and treasurers would reduce to writing their wealth of knowledge on these subjects.

When I was invited to present a paper to this convention, my first plan was to pass in review some of the leading water-works books and stop with them. On reflection it has seemed advisable to substitute for such a review as complete a list as I could prepare of all the distinctively water-works books published in this country and add to that list a considerable number on more or less closely allied subjects. Aside from adding very brief comments on a few books or groups of books, partly to explain why they are included, I shall leave the task of specific criticism to the members of the association. If a liberal response is made to the invitation thus extended, and particularly if titles of books are suggested for addition or for omission, I may be encouraged to take up; at a later date, a more specific criticism of some of the books. No one person, it is evident, can be expected to pass valid judgment on each book in so long a list, which is one reason why I have not undertaken the task. This association as a whole is competent to criticise ably every book in the list, and I submit that such a body of criticism would be of great value to the profession, and also to the authors and publishers of future books on these and related topics.

As has already been stated, I have aimed to include in the appended list all American books known to me that deal specifically with water-works; or perhaps I should say, all general water-works books and most of the books dealing specifically with some distinct phase of water-works. Naturally the list is headed by the most general or inclusive books, which are five in number.

Turneaure and Russell's "Public Water Supplies" is placed first because of its comparative recentness, comprehensive character and extended bibliographies at the end of the chapters.

Fanning is fifth in the list because of its need of revision.

Folwell's "Water Supply Engineering" is a smaller book than Turneaure's, and lacks the bibliographies (although it has references in the text), but it is a useful work.

Goodell's "Water-Works for Small Cities and Towns" is valuable for large works as well as small. It contains numerous citations from well-known engineers on questions of design and construction and is well worth buying even by those who generally limit themselves to one book to a topic.

Gould's "Elements of Water Supply Engineering" has been produced by successive additions of other matter from the late author's earlier "Practical Hydraulic Formula."

A few of the other books near the head of the list may be mentioned briefly, as follows:

Mead's "Notes on Hydrology" is the most recent of the books on water supply, as contrasted with the broader subject of water-works, and is valuable for its many diagrams and full bibliographical lists.

Billings' "Details of Water-Works Construction" deals almost wholly with pipe-laying and though rather old it is the most complete presentation of the subject available.

Meyer's "Water Waste Prevention" is older still and is not representative of present American practice, but it is nevertheless of value.

Both Hill and Mason confine themselves more particularly to questions affecting the quality of water.

Wilson's "Irrigation Engineering" has much in common with the general books on water-works, and is particularly valuable for Western men.

Of the next fourteen books nothing need be said, since their titles indicate their general scope sufficiently. Going on down the list, only an occasional book will be mentioned here.

Schuyler's "Reservoirs" is largely descriptive of quite a range of Western practice, including rock-fill and hydraulic-fill dams.

Wegmann's "Dams" is a standard technical work.

Hazlehurst's "Tanks and Towers" contains practically nothing on wood stave tanks.

Beginning with Johnson's "Surveying" about twenty books are given, all of which will be useful in large offices and from which selections can be made for small offices. It will be seen that these books deal with methods of doing work, materials of construction, contracts and specifications and other legal points.

There is no satisfactory book on plumbing, but Gerhard's "Sanitary Engineering of Buildings" and Clark's "Care of the House," taken together, go far towards filling the gap. Clark's book is cram full of practical information on the selection and care of plumbing and heating apparatus, woodwork and other parts of a building and its equipment.

Wait's "Law of Operations Preliminary to Construction" should be particularly valuable to water-works men because it deals at length with water rights and allied subjects, the condemnation of land and municipal franchises.

Something on geology, meteorology and physics should certainly be found in all the larger water-works offices.

The books on forestry are suggested in view of the reforesting of drainage areas already begun by a number of water-works and the desirability of extending such work. The book on identifying trees is useful and suggestive, and the one on species of wood is even more practical in character.

The creditable desire of water-works officials to beautify the grounds around their pumping stations and reservoirs suggests the need for a book on landscape architecture or gardening. The smaller of the two books by Parsons contains much that is in the larger one and is handier and cheaper. It would be particularly useful in planning the improvement of relatively small grounds around pumping stations and keepers' cottages, besides being of use to any one having private grounds.

The esthetic improvement of cities as a whole should appeal to all classes of city officials and to all public service or franchise companies. This subject is ably treated in the two books, near the end of the list, by Robinson. The first and smaller of the two deals with some of the more practical aspects of the subject, such as orderliness, convenience and cleanliness, which should receive attention before beautification without ridiculous contrasts is possible. The book on judging architecture will be useful both in connection with the general problem of municipal esthetics and as an aid to forming a correct taste for judging the architectural merits and demerits of proposed buildings for water-works purposes.

The last six books named, like those by Robinson, also deal with general municipal problems, and like Robinson's are inserted because the water-works official should never forget that he is a part of the municipal whole and as such should try to be informed on all those subjects affecting the city at large which come within his range of possible influence. The first of the six books, Whinery's "Municipal Public Works," however, contains many facts and suggestions bearing directly and indirectly upon the water-works department. My own little book on "Municipal Engineering and Sanitation," named earlier in the list, discusses some of the questions taken up by Mr. Whinery and in addition many general phases of municipal government, including charters, boards of public works, and uniform municipal accounting. There are a number of good books on municipal government which might be included in the list, but of these only Wilcox's "American City" and Shaw's two books have been inserted. Wilcox's book is given because in it, as its subtitle indicates, the relation of city growth to democratic institutions is considered. Shaw's books are mentioned because every municipal official should know something of the way municipal works are conducted abroad.

Bemis' "Municipal Monopolies" and Darwin's "Municipal Trade," the latter being a British book, present the two sides of the municipal ownership question in detail. Most of the arguments and statistics in Bemis are designed to prove the superiority of municipal ownership. Darwin presents arguments (he gives few or no statistics) on both sides, but on the whole he is strongly in favor of private ownership, except for water-works.

It may have been noticed by some that my [illegible] no book on water-works finance, accounting, [illegible] management. With more time at my disposal [illegible] something more or less adaptable to water-[illegible] could have been found on accounting and on [illegible] management. I trust to the members of the [illegible] to supply the deficiency. The broader phases [illegible] accounting, with special reference to uniform [illegible] have been under consideration for a number of [illegible] by a committee of the National Municipal League [illegible] Edward M. Hartwell, Secretary Statistics [illegible], Boston, Mass.).

In conclusion, I wish to return to a subject [illegible] earlier in this paper: the lack of books on [illegible] management. With the possible exception of [illegible] for stationary engineers and firemen, which [illegible] attempted to look up, there is practically not [illegible] management of water-works. This lack is quite in keeping with one of the most notable features of American municipal government, the often lavish expenditure for constructing public works and the frequent niggardly appropriations for repairs and maintenance. Probably water-works have suffered less in this particular than most municipal works, because water-works produce revenue and are often in the hands of independent departments which take pride in keeping them in first-class condition. Be this as is may, a comprehensive book on water-works management and operation, or a series of such books on separate branches of the subject, is one of the greatest needs of the water-works man. What can and will this association, as a whole and through its individual members, do to make good the deficiency?

SUGGESTED LIST OF BOOKS FOR THE WATER-WORKS OFFICE.*

Public Water Supplies.—By F. E. Turneaure and H. L. Russell, Ph. D. With a Chapter on Pumping Machinery by D. W. Mead. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 746; 101 tables and 221 illustrations. $5.

Water-Supply Engineering.—By A. Prescott Folwell. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 576; 79 tables, 19 plates, and 95 text illustrations. $4.

Water-Works for Small Cities and Towns.—By John Goodell. New York: The Engineering Record. Cloth; 6 × 9 ins.; pp. 286; tables and 53 figures in the text. $2.

The Elements of Water-Supply Engineering.—By E. Sherman Gould. New York: The Engineering News Publishing Co. Cloth; 6 × 8¾ ins.; pp. 168; three tables and 29 figures in the text. $2.

A Practical Treatise on Hydraulic and Water-Supply Engineering.—By J. T. Fanning. New York: D. Van Nostrand Co. Cloth; 6 × 9¼ ins.; pp. 644; 121 tables and 225 illustrations. $5.

Notes on Hydrology.—By Daniel W. Mead. Chicago: The Author. Cloth; 6 × 9¼ ins.; pp. 202; 43 tables, 19 maps and 46 text illustrations. $2.

Some Details of Water-Works Construction.—By William R. Billings. New York: The Engineering Record. Cloth; 6 × 9 ins.; pp. 96; 28 figures in the text. $2.

Water-Waste Prevention.—By Henry C. Meyer. New York: The Sanitary Engineer (now the Engineering Record, or McGraw Publishing Co.). Cloth; 6 × 9 ins.; pp. 70; three figures in the text. $1.

The Purification of Public Water Supplies.—By John W. Hill. New York: D. Van Nostrand Co. Cloth; 6 × 9¼ ins.; pp. 304; tables, and 32 figures in the text. $3.

Water Supply.—(Considered Principally from a Sanitary Standpoint.) By William P. Mason. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 448; illustrated. $4.

Water and Public Health.—By James H. Fuertes. New York: John Wiley & Sons. Cloth; 5 × 7½ ins.; pp. 75; 70 illustrations. $1.50.

Principles of Sanitary Science and the Public Health.—By William T. Sedgwick. New York: The Macmillan Co. Cloth; 6 × 9 ins.; pp. 368; folding and other plates. $3.

Municipal Engineering and Sanitation.—By M. N. Baker. New York: The Macmillan Co. Cloth; 5 × 7½ ins.; pp. 317. $1.25.

Potable Water and Methods of Detecting Impurities.—By M. N. Baker. New York: D. Van Nostrand Co. Boards; 4 × 6 ins.; pp. 97. 50 cts.

Industrial Uses of Water.—By H. de la Coux. Translated from the French and Revised by Arthur Morris. London: Scott, Greenwood & Co. New York: D. Van Nostrand Co. Cloth; 6½ × 10 ins.; pp. 354; 135 figures in the text. $4.50 net.

Examination of Water.—(Chemical and Bacteriological.) By William P. Mason. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 131. $1.25.

Elements of Water Bacteriology.—By Samuel Cate Prescott and Charles-Edward Amory Winslow. New York: John Wiley & Sons. Cloth; 5 × 8 ins.; pp. 162; tables and one figure in the text. $1.25.

An Introduction to the Bacteriological Examination of Water.—By W. H. Horrocks. London: J. & A. Churchill. Cloth; 6 × 9 ins.; pp. 300; five plates. $4.20.

The Microscopy of Drinking Water.—By George Chandler Whipple. New York: John Wiley & Sons. Cloth; 6 × 9¼ ins.; pp. 300; 19 plates and 21 text illustrations. $3.50.

The Microscopical Examination of Potable Water.—By George W. Rafter. New York: D. Van Nostrand Co. Boards; 3¼ × 6 ins.; pp. 160; folding and other tables, and two figures. 50 cts.

Micro-Organisms in Water.—By Prof. Percy Frankland and Mrs. Percy Frankland. New York: Longmans, Green & Co. Cloth; 6 × 9 ins.; pp. 532; two plates and 28 text illustrations. $3.

Air, Water and Food.—By Ellen H. Richards and Alpheus G. Woodman. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 226; tables, and 12 illustrations. $2.

Elements of Applied Microscopy.—By Charles-Edward Amory Winslow. New York: John Wiley & Sons. Cloth; 5 × 7½ ins.; pp. 183; 60 figures in the text. $1.50.

The Filtration of Public Water Supplies.—By Allen Hazen. New York: John Wiley & Sons. Cloth; [illegible] × 9 ins.; pp. xii + 321; tables, plates and 35 text illustrations. $3. English price, 12s. 6d.

Water Filtration Works.—By James H. Fuertes. New York: John Wiley & Sons. Cloth; 5 × 8 ins.; pp. xviii + 283; 45 figures and 20 half-tone plates. $2.50.

*A paper by M. N. Baker, Associate Editor Engineering News, Editor Engineering Literature Supplement, read at the Twenty-fifth Annual Convention of the American Water-Works Association, held at West Baden, Ind., May 8 to 14, 1905.

*To economize space in reprinting the descriptions of the several books are here somewhat curtailed.

Report on the Investigations Into the Purification of the Ohio River Water at Louisville, Kentucky.—By George W. Fuller. New York: D. Van Nostrand Co. Cloth; 6 × 12 ins.; pp. 461; tables, and eight plates. $10.

Reservoirs for Irrigation, Water Power and Domestic Water Supply.—By James Dix Schuyler. New York: John Wiley & Sons. Cloth; 7 × 10½ ins.; pp. 414; tables, 25 plates, and 183 figures. $5.

The Design and Construction of Dams.—By Edward Wegmann. New York: John Wiley & Sons. Cloth; 9½ × 12½ ins.; pp. 250; 24 tables, 95 plates, and 75 text illustrations. $5.

Existing Dams.—By Burr Bassell. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. xi + 70; 31 illustrations in the text. $1.

Tanks and Tanks for Water-Works.—By J. N. Hazlehurst. New York: John Wiley & Sons. Cloth; 5¾ × 8½ ins.; pp. 325; illustrated. $2.50.

Irrigation Engineering.—By Herbert M. Wilson. New York: John Wiley & Sons. Cloth; 6 × 8 ins.; pp. 523; many tables, 41 plates, and 142 figures in the text. $4.

Water-Power.—By Joseph P. Frizell. New York: John Wiley & Sons. Cloth; 6 × 9¼ ins.; pp. 563; 26 tables, and 233 figures in the text. $5.

Steam Power Plants.—By Henry C. Meyer. New York: McGraw Publishing Co. Cloth; 6 × 9 ins.; pp. 159; 16 folding plates, and 65 figures in the text. $2.

The Mechanical Engineering of Power Plants.—By Frederic Remsen Hutton. New York: John Wiley & Sons. Cloth; 6 × 9¼ ins.; pp. 725; 512 figures in the text. $5.

The Steam Engine and Gas and Oil Engines.—By J. Perry. New York: The Macmillan Co. Cloth; 6 × 9 ins.; pp. 646; 325 text figures. $3.25 net.

Steam Boilers, Their Theory and Design.—By H. de B. Parsons. New York: Longmans, Green & Co. Cloth; 6 × 9 ins.; pp. 375; many tables and 135 figures in the text. $4 net.

Pumping Machinery.—By William M. Barr. Philadelphia: J. B. Lippincott Co. Cloth; 6 × 9¼ ins.; pp. 447; 264 illustrations. $5.

Chimney Design and Theory.—By William Wallace Christie. New York: D. Van Nostrand Co. Cloth; 6 × 9 ins.; pp. 192; 53 illustrations. $3.

Civil Engineer's Pocket-Book.—By John C. Trautwine. Revised by John C. Trautwine, Jr., and John C. Trautwine, 3d. New York: John Wiley & Sons. Leather; 4¼ × 6¾ ins.; pp. xxxii + 1,079; many tables and illustrations. $5.

The Mechanical Engineer's Pocket-Book.—By William Kent. New York: John Wiley & Sons. Morocco; 4¼ × 6¾ ins.; pp. xxxii + 1,129; many tables and illustrations. $5.

Treatise on Hydraulics.—By Mansfield Merriman. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 593; 55 tables, and 199 figures in the text. $5.

The Elements of Water Supply Engineering.—By E. Sherman Gould. (See No. 4 on list.)

Tables Showing Loss of Head Due to Friction of Water in Pipes.—By E. B. Weston. New York: D. Van Nostrand Co. Flexible Leather; 4 × 6 ins.; pp. 171. $1.50.

The Graphical Solution of Hydraulic Problems.—By Freeman C. Coffin. New York: John Wiley & Sons. Leather; 4¾ × 7½ ins.; pp. 79; 13 tables and 39 diagrams. $2.50.

Hydraulic Diagrams for the Discharge of Conduits and Canals.—Based upon the Formula of Ganguillet and Kutter. By Charles H. Swan. New York: The Engineering News Publishing Co. Cloth; 6 × 9¼ ins.; pp. 43. $1.

The Manual of American Water-Works, 1897.—Edited by M. N. Baker. New York: The Engineering News Publishing Co. Cloth; 6 × 9¼ ins.; pp. 611 + lxiv. $3.

The Municipal Year Book, 1902.—Edited by M. N. Baker. New York: The Engineering News Publishing Co. Cloth; 6 × 9¼ ins.; pp. liv. + 310. $3.

The Theory and Practice of Surveying.—By J. B. Johnson. New York: John Wiley & Sons. Cloth; about 900 pages; illustrated. $4.

Lettering for Draftsmen, Engineers and Students.—By Charles W. Reinhardt. New York: D. Van Nostrand Co. Boards; 11 × 8 ins.; pp. 34; 12 plates, and over 50 illustrations in the text. $1.

The Technic of Mechanical Drafting.—By Charles W. Reinhardt. New York: The Engineering News Publishing Co. Boards; 11 × 8 ins.; pp. 42; 11 full-page plates, and many illustrations in the text. $1.

Sanitary Engineering of Buildings.—By William Paul Gerhard. Volume I. New York: William T. Comstock. Cloth; 7 × 10¼ ins.; pp. 454; six plates and 103 text illustrations. $5.

Care of the House.—By T. M. Clark. New York: The Macmillan Co. Cloth; 5 × 7½ ins.; pp. 284. $1.50 net.

The Materials of Construction.—By J. B. Johnson. New York: John Wiley & Sons. Cloth; pp. xv. + 795; 11 plates and 650 illustrations. $6.

A Treatise on Masonry Construction.—By Ira O. Baker. New York: John Wiley & Sons. Cloth; pp. about 600; 160 figures and six folding plates. $5.

A Treatise on Concrete, Plain and Reinforced.—With Chapters by R. Feret, William B. Fuller and Spencer B. Newberry. By Frederick W. Taylor and Sanford E. Thompson. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. 585; 176 figures in the text. $5.

Reinforced Concrete.—By A. W. Buel and C. S. Hill. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 434; tables, and 311 figures, some on folding plates. $5.

Reinforced Concrete.—By Charles F. Marsh. New York: D. Van Nostrand Co. Cloth; 8 × 11 ins.; pp. 345; tables, and 512 illustrations, mostly in the text. $7 net.

Cements, Mortars and Concretes.—By Myron S. Falk. New York: M. C. Clark. Cloth; 6 × 9 ins.; pp. 176; tables, plates and figures in the text. $2.50.

Earthwork and Its Cost.—By Halbert Powers Gillette. New York: The Engineering News Publishing Co. Cloth; 5 × 8 ins.; pp. 244; tables, folding plates and illustrations in the text. $2.

Rock Excavation.—By Halbert Powers Gillette. New York: M. C. Clark. Cloth; 6½ × 8 ins.; pp. 376; 56 figures in the text. $3.

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Engineering Contracts and Specifications.—By J. B. Johnson. New York: The Engineering News Publishing Co. Cloth; 6 × 9 ins.; pp. 566. $3.

The Law of Operations Preliminary to Construction in Engineering and Architecture.—By John Cassan Wait. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. lxiii. + 638. $5; $5.50.

Engineering and Architectural Jurisprudence.—By John Cassan Wait. New York: John Wiley & Sons. Cloth; 6 × 9 ins.; pp. lxxx. + 905. $6; $6.50.

Elements of Geology.—By J. Le Conte. Revised and Partly Rewritten by Herman LeRoy Fairchild. New York: D. Appleton & Co. Cloth; 6 × 9 ins.; pp. 667; one plate and 1,002 text illustrations. $4.

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University Physics.—By H. S. Carhart. Boston: Allyn & Bacon. Cloth; 5¼ × 7½ ins. Vol. I.; pp. 344; 153 text figures. Vol. II.: pp. 450; 228 text figures. $1.50 per volume.

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How to Judge Architecture.—By Russell Sturgis. New York: The Baker & Taylor Co. Cloth; 6½ × 9¼ ins.; pp. 221; 55 plates. $1.50 net.

Municipal Public Works.—By S. P. Whinery, C. E. New York: The Macmillan Co. Cloth; 6 × 8 ins.; pp. 241. $1.50 net; by mail, $1.63.

The American City.—A Problem in Democracy. By Delos F. Wilcox. New York: The Macmillan Co. Half leather; 5 × 8 ins.; pp. 423. $1.25.

Municipal Government in Great Britain.—By Albert Shaw. New York: The Macmillan Co. Cloth; 6 × 8½ ins., pp. 348. $2 net.

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Municipal Monopolies.—Edited by Edward W. Bemis. New York: Thomas Y. Crowell & Co. Cloth; 5 × 8 ins.; pp. 691. $2.

Municipal Trade.—By Major Leonard Darwin. New York: E. P. Dutton & Co. Cloth; 6 × 9 ins.; pp. 464. $3.50 net.

TRANSACTIONS OF THE AMERICAN ELECTROCHEMICAL SOCIETY.—Vol. VI. Sixth General Meeting, St. Louis, Mo., Sept. 13-16, 1904. Philadelphia: The American Electrochemical Society. Cloth; 6 × 9¼ ins.; pp. 195; numerous tables and illustrations in the text.

This volume covers separately the individual session of the society at the St. Louis meeting, and the joint sessions of the Society and Section C of the International Electrical Congress. It is prefaced by an excellent portrait of the first secretary, Mr. C. J. Reed. The papers which (with their discussions) appear in the volume are:

"An Analytical Study of the Deposition of Aluminum from Ethyl Bromide Solution," by H. E. Patten; "The Aluminum Rectifier," by Prof. W. D. Bancroft; "Some Aspects of Applied Electrochemistry," by W. M. Johnson; "The Use of Carbon for the Study of Temperatures in the Electric Furnace," by F. J. Fitzgerald; "The Electrolytic Purification of Cobalt and Nickel," by Prof. W. D. Bancroft; "Electrochemical Exhibits at St. Louis," by S. S. Sadtler; "The Relation of the Hypothesis of Compressible Atoms to Electrochemistry," by Prof. T. W. Richards; "Electrical Extraction of Nitrogen from the Air," by J. S. Edström; "The Chemistry of Electroplating," by Prof. W. D. Bancroft; "The Carbon Cell," by Profs. F. Haber and L. Bruner; "The Electrochemical Series of Metals," by Prof. L. Kahlenberg; "The Lead Voltameter," by A. G. Betts and E. F. Kern; "Chlorine in Metallurgy," by J. Swinburne; "Aluminothermics," by H. Goldschmidt; "The Silver Voltameter," by K. E. Guthe; "The Materials Used in Standard Cells and Their Preparation," by Profs. H. S. Carhart and G. A. Hulett; "The Electrometallurgy of Iron and Steel," by P. L. T. Heroult; "The Present Status of the Edison Storage Battery," by Prof. A. E. Kennelly and S. E. Whiting; "Electrolytic Conduction," by Prof. J. W. Richards; "The Electrolysis of Fused Salts," by Prof. R. Lorenz; "Electrolysis and Catalysis," by Prof. W. Ostwald. ¾

CAR INTERCHANGE MANUAL.—McConway & Torley Co., Pittsburg, Pa. 3½ × 5¾ ins.; pp. 207.

This pamphlet, compiled and published by J. D. McAlpine, of Cleveland, consists mainly of abstracts of the Arbitration Committee of the Master Car Builders' Association up to the end of 1904. There is also some useful information as to values of cars, wear of tires, first aid to the injured, etc. The cases from May to December, 1904, are also printed separately, so that they can be inserted in the 1904 edition of the Manual.

REPORT OF THE DIRECTOR OF THE OFFICE OF EXPERIMENT STATIONS FOR 1904.—By A. C. True. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 445 to 523.

Every State and Territory in the Union now has one or more agricultural experiment stations. Besides reviewing the work of the national government in relation to these stations and other activities, this pamphlet contains about twenty pages on the irrigation and drainage investigations carried on under the direction of Mr. Elwood Mead, M. Am. Soc. C. E.

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PREFACE TO SEVENTH EDITION

OCTOBER, 1904

An entirely new index has been made, with about twice as many titles as the former index. The electrical engineering chapter has been further revised and some new matter added. Four pages on Coal-handling Machinery have been inserted at page 911, and numerous minor changes have been made.

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Electric Railway Practice.

Reviewed by Henry H. Norris.*

ELECTRIC RAILWAYS.—Theoretically and Practically Treated. By Sydney W. Ashe, B. S., Assoc. M. Am. Inst. E. E., Department of Electrical Engineering, Polytechnic Institute of Brooklyn; and J. D. Kelley, Electrical Engineering Department, New York Central Railroad. New York: D. Van Nostrand Co. Cloth; 5½ × 8 ins.; pp. 285; six folding plates and 172 text illustrations. $2.50.

As stated in the preface, the authors have been led to prepare this volume on account of the lack of a modern text-book upon the subject. They are correct in stating that there is no such book, and it is doubtful if, in the present state of the art, such a book can be prepared. Electric railway practice is at present far from being in a settled state, and very little of this practice can be called standard. However, the present work will prove very convenient for reference in regard to the various features of electric car and train operation, and it is as complete as it would be wise to make it at the present time. It gathers into small space the information otherwise obtainable only in the trade and periodical literature, and it is put into readable style with numerous and satisfactory illustrations.

In brief, the plan of the book is to cover first a few essential principles of motor and car operation, including the testing of equipments. Next the component parts of the car equipment are treated in detail.

A general criticism which may be made on all parts of the work is that every subject is treated too briefly, in fact, one might almost say hurriedly. This is particularly true of the sections treating of motor and train operation characteristics. Another possible fault in the work is that particular types of apparatus are treated in specific terms, while little attention is paid to the general underlying features of successful practice. The result of this will be that without very frequent revision it will be impossible to keep the book up-to-date, and it must be regarded more as a contribution to current than to permanent literature on the subject.

Leaving aside these general faults, however, it is a pleasure to commend the many good features of the book. In the first place, the material is excellent, and it is well arranged for general reading and for reference. It also lends itself readily to division into recitation sections for class-room use, for which it was evidently originally prepared. The authors show that they possess a general perspective of their subject, a qualification absolutely essential in the preparation of a work of this kind.

The volume opens with a few preliminary paragraphs dealing with units of measurement, curve plotting, and mechanical devices for facilitating calculations. After this a chapter is devoted to the analysis of motor and train performance. Under this head are briefly treated the following elements of train and motor performance: Motor characteristics, time-speed curves, and current and power curves of complete train operation. This chapter is followed by one dealing with a few of the instruments used in electric car testing.

A short chapter is devoted to the direct-current series motor, and its construction and operation are described. Some excellent illustrations of modern motors, including that recently built for the New York Central Railroad, are given here and these greatly facilitate the understanding of the text. Various types of alternating-current motors are taken up in the fifth chapter, and their theory is given in simple non-mathematical form, with elementary conventional diagrams. A few details of the alternating-current motor built by the Westinghouse Company for the Washington, Baltimore & Annapolis Railway indicate the practical form of the modern alternating-current single-phase motor.

The chapters on control systems are ample and this subject is treated in a clear and satisfactory manner. The larger part of the space is given to modern multiple-unit automatic control systems. These systems are in use on all roads where very large currents must be handled. The authors describe fully, with numerous illustrations and diagrams, the Westinghouse and General Electric types of control, such as are used on the Interborough Rapid Transit Railway (Elevated and Subway) in New York, on the South Side Elevated Railway of Chicago, and other large systems. The necessity for the use of such controllers is pointed out and the underlying principles of the successful adaptation of the original Sprague type of control to recent requirements are clearly indicated.

Next in order are treated very briefly the construction of car bodies and trucks. Of these a few important features are pointed out. Most attention is given to the construction of fireproof cars and the matter of car heating is, rather inconsistently, referred to. At this point the illustrations show the framing and general lay-out of a number of special cars and of one or two standard types. An interesting under-view of a modern car shows the great amount of auxiliary apparatus which is now considered essential for its successful operation. The chapter on trucks is entirely descriptive in nature but it is clear, well illustrated and includes those matters which are concerned with the adaptation of electric motors and trucks to each other.

A comparatively long chapter is devoted to the subject of brakes and braking and the fundamental features are treated by means of elementary mathematics, rather fully in comparison with the handling of other sections of the book. Diagrams of brake rigging are given and special brakes of the magnetic and momentum types are shown. The air brake is given its deserved share of attention. A number of braking curves show the possible rates of deceleration for an 18-ton car with several durations of deceleration, varying from 11 to 6 seconds, from a maximum speed of 18 mi. per hr.

Brief mention is made of the subject of electric locomotives, but this chapter is very incomplete and does not do the important subject justice. The book closes with a short section on electrical measurements as applied to electric railways.

As a whole the volume may be cordially commended to readers who desire to have in convenient and compact form a resumé of the present state of the art of electric railroading. The work is much less complete than that of Mr. Philip Dawson, but it is correspondingly inexpensive. It is undoubtedly more complete than any other concise treatment of the subject.

*Assistant Professor of Electrical Engineering, Cornell University, Ithaca, N. Y.

LIVES OF THE ENGINEERS GEORGE AND ROBERT STEPHENSON.—By Samuel Smiles, Author of "Character," "Self-Help," etc. The Locomotive. London: John Murray. Cloth; 5 × 8 ins.; pp. xliv + 466; seven plates and 68 text figures. 3s. 6d.; American price, $1.40.

It would be well worth the while of every engineer to read or reread the lives of the two Stephensons, father and son. George, the older of the two, affords a marvelous example of what can sometimes be accomplished by a man who is not only self-taught, but virtually a pioneer, as Stephenson was in railway building and locomotive construction. Smiles' "Lives of the Engineers" has been too long before the public to demand criticism here. It is only necessary to say that the series of five volumes, of which the book before us is one, is being reprinted in handy, serviceable form, from large, clear type and with numerous engravings.

THE ITALIAN IN AMERICA.—By Eliot Lord, A. M., Special Agent U. S. Tenth Census, Social Statistics; John D. Trenor, Chairman of Immigration Committee, National Board of Trade, Annual Session, 1904; and Samuel J. Barrows, Secretary of the Prison Association of New York. New York: B. F. Buck & Co. Cloth; 5½ × 8¼ ins.; pp. 268; illustrated. $1.50.

The authors state that their aim has been "to present clearly the contribution of Italy to American development and citizenship," and that the book "is one of a series reviewing the influx of the various social strains and nationalities that are making up the composite America." There are chapters on Italian emigration to this country and its regulation in Italy, on Italian conditions affecting emigration, on Italians in American cities, in our mining fields, and on farms and plantations. The demand for Italian immigrant labor and the need for better distribution are discussed as also pauperism, disease and crime, education and assimilation and duties of citizenship. The book is optimistic, discriminating and instructive.

Weather Forecasting Fallacies.

LONG-RANGE WEATHER FORECASTS.—By E. [illegible] Garriott, Professor of Meteorology, Washington U[illegible]. Prepared under the direction of Willis L. Moore, [illegible] U. S. Weather Bureau. Washington, D. C. [illegible] Department of Agriculture. Paper; 6 × 9 ins.; [illegible] pp.

The substance of this Weather Bureau b[illegible] is rather remarkable, and will prove of int[illegible] to many classes of men. The bulletin is a for[illegible] nunciation, on the part of the Government's [illegible]eorological bureau, of weather forecast[illegible] and forecasts that pretend to describe the m[illegible]tures of the weather for long periods ah[illegible] riods much longer than those covered [illegible] the geographical progression of storms, floo[illegible] old waves, and the like across the corres[illegible]ding areas of observation. The motive cause [illegible] the publication is expressed thus in the prefac[illegible]

> The success of the United States Weather B[illegible] in making conservative forecasts of the weather two or three days in advance has created the hope in the mi[illegible] of the people that it may be possible to foresee the cha[illegible]er of the weather for the coming month or season. A[illegible] scientific men know that at present it is impossible to gratify this wish. . . . But the mistaken investigator of little knowledge, the pseudo-scientist and the astrologer, see their opportunity and at once step into the br[illegible] and sell spurious long-range forecasts to a public rendered credulous by the success of the Government [illegible]. . . . The publication of monthly forecasts has reached such proportions that it is deemed advisable to inform the public as to their harmful character.

Curious, that in this year of 1905 a government document should be required to inform the American public against astrologers!

Three papers are contained in the bulletin. Professor Garriott introduces the subject by a short introductory paper that gives some comparisons between long-range forecasts and actual occurrences. Then is reprinted a long paper by Prof. C. M. Woodward, of St. Louis, written in 1875, in which an elaborate "planetary equinox" theory, evolved by a Missouri "pseudo-scientist," is unmercifully cut to pieces. Finally, the second half of the bulletin gives, from the pen of Professor Garriott, a long series of authoritative utterances, by meteorologists and other scientists, on the subject of long-range forecasts of various kinds. The bulletin may serve many an engineer as an interesting bit of reading for hours of relaxation.

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ENGINEERING NEWS, 220 Broadway, New York

Experiments on the Flow of Steam.

Reviewed by Strickland L. Kneass,* M. Am. Soc. M. E.

EXPERIMENTAL RESEARCHES ON THE FLOW OF STEAM THROUGH NOZZLES AND ORIFICES.—To Which is Added a Note on the Flow of Hot Water. By A. Rateau, Engineer of the Mining Corps, Professor in the Ecole Supérieure des Mines, Paris. Reprint from the "Annales des Mines," January, 1902. Authorized Translation by H. Boyd Brydon. New York: D. Van Nostrand Co. Cloth; 5 × 7½ ins.; pp. 76; tables, four figures in the text and four folding plates. $1.50 net.

Professor Rateau is well known on both sides of the Atlantic in connection with original work on the steam turbine and from his investigations in thermodynamic lines which have appeared in frequent memoirs in French scientific periodicals. This little book on the flow of steam is an expansion of his report to the Congress of Applied Mechanics in 1890. His work is painstaking in the extreme; results of 300 separate tests with elaborate calculations of weights and velocities of discharge cover 15 pages of closely printed tables.

The object of the investigation was to determine the conditions governing the discharge from large conoidal convergent nozzles and an orifice in a thin plate, both above and below the ratio p = 0.58 P. Three sizes were used: 10.49 mm. (13/32"+), 15.19 (19/32"+) and 24.20 (61/64"+), and an orifice in a thin plate, 20.12 (7/8"). These are exceptionally large units and without a large boiler and condenser plant it would have been difficult to have obtained results. The apparatus is shown by folding plates and indicates much care in the design, and from a theoretical standpoint would seem to leave little to be desired, but a number of details will be considered later.

Steam was supplied to the testing nozzle by a 2-in. pipe connected to a centrifugal separator; the discharge from the nozzle passed into a 5-in. communication with an ejector condenser, provided with an adjustable concentric water nozzle to vary the discharge area from the 5-in. exhaust pipe, and so vary the pressure against which the steam discharged. The volume and weight of the combined water and condensed steam were calculated from the measured head when flowing from a reservoir provided with a calibrated nozzle. From observations of the initial and final temperatures and head, the weight of steam was calculated for given steam pressures; the duration of each test was two or three minutes, maximum initial pressure, 160 lbs. and minimum terminal, 2 lbs. (absolute). Several diagrams of plotted results are of much interest.

Commenting upon Professor Rateau's methods and results, it may be noted that all pressures below that carried upon the boiler are obtained by throttling; it is doubtful if superheating does not result, especially as no observation seems to be recorded of the temperature of the entering steam; the tables indicate saturation. The duration of the experiments would seem to be insufficient for the thermometers to read to the required accuracy of 1.20°C., as the heat of the delivered water was transmitted through a steel cup filled with mercury. In the calculations of the discharge of the calibrated water nozzle, no allowance is made for the change of volume of the condensing water between the limits of temperature used, 17.02 C. to 50.98°C., which would amount to about 1%; further, the accuracy of the results depends upon observations of small differences and an accumulation of almost infinitesimal errors in observations would lead to wide discrepancies. The head of discharge was measured by a water glass, instead of a needle point on the surface.

His conclusions confirm the well-known experiments of record; the discharge is about 1% in excess of the thermodynamic formulas and greater than that given by Rankine's approximate formula, which would seem to be sufficiently close for ordinary use. He suggests the use of Grashof's formula with a slight modification of the constants, as giving results corresponding with his experiments. He notes also that the coefficient of discharge of conoidal nozzles is practically unity, showing that experiments with smaller nozzles can be used as the basis for determining the flow from larger sizes used in turbine construction.

*418 South Fifteenth St., Philadelphia.

The author closes with an interesting note on the flow of hot water, confirming some of Zeuner's conclusions. The book is well printed in large type on heavy paper. One or two obvious typographical errors are noted. It is an interesting addition to the literature on the flow of steam through nozzles.

THE LABORATORY FOR THE TESTING OF ROAD MATERIALS AT COLUMBIA UNIVERSITY.—With Observations on Current Practice. By A. Black, C. E. (Reprinted from the School of Mines Quarterly.) Paper; 6 × 9¼ ins.; pp. 28; seven tables and eight figures in the text.

For the last five years, since the installation of a laboratory for the testing of road materials at Columbia University, Mr. Black has had charge of the testing, and a large amount of work has been done, especially for the highway department of the State of New York. Among the tables is a valuable five-page table summarizing the results of tests on New York State road metal.

Brief as this pamphlet is, the discussion of the testing of road materials is the best that we have seen. At the outset it must be admitted that much yet remains to be done before the laboratory tests of materials will be wholly satisfactory to the road builder. Mr. Black himself states that

"The cementation test as practised at present is not entirely satisfactory."

He then makes two excellent suggestions for increasing the value of the cementation test. The first suggestion is that the briquette should not consist solely of fine rock dust, but should be made of dust and coarser materials of a standard size, so as to approximate the conditions in actual practice. He adds:

The size of the test specimen might well be made larger, to reduce the influence on the results of small accidental defects in the piece.

We desire to go one step farther and suggest that the *macadam* briquette thus made should be tested under compression, as cubes of concrete are tested, instead of being subjected to the repeated pounding of a miniature hammer, as at present is the practice. The number of blows that a briquette will stand is now called the "cementation value" of the given stone dust. A briquette that will stand 20 blows has apparently twice as great cementation value as one that stands 10 blows. Yet a little thought shows how absurd such a conclusion is; for the 20-blow briquette may not have more than 1¼ times the compressive strength or 1½ times the shearing strength or 1⅛ times the tensile strength that the 10-blow briquette. In a word, the present method of rating by blows means nothing from the standpoint of static stress. It means next to nothing from the standpoint of impact stress, for in practice the road is not subjected to the miserable little blows of a kilogram weight falling one centimeter, but must stand the great blows delivered by wheels and hoofs. Mr. Black's suggestion that the size of the test specimen be increased and that an aggregate be mixed with the stone dust is a long step in the right direction.

An interesting diagram in the pamphlet shows the relation of the coefficient of wear to the number of revolutions. It is particularly noteworthy that the curve of wear gradually approaches a horizontal line. This in itself would seem to indicate the unreliability of the rattler test, and it may ultimately lead to the use of the rubbing or abrasion test which Mr. Black describes as being frequently used in France.

SOIL SURVEY OF THE LONG ISLAND AREA, NEW YORK.—By Jay A. Bonsteel and Party. U. S. Department of Agriculture, Bureau of Soils; Milton Whitney, Chief. Washington, D. C.: Pub. Doc. Paper; 6 × 9 ins.; pp. 42; two folding maps and one map in text.

This publication gives the results of the surveys made in 1903 by the Department of Agriculture to determine the nature and extent of the surface soils of western Long Island with the view of their best adaptation to farming and gardening purposes, and also with a view to the possibilities of irrigation. The soils are classified into several groups, each of which is described in character and extent and in respect to its adaptation to crop raising. The present agricultural conditions in the area surveyed are briefly described and their possible future development is discussed at some length. A list of the kinds of crops which each soil is best adapted to grow is given.

A CHAPTER ON BRICKWORK.—Comprising Matter on Brickwork Calculations, Plastering, Mortars, Cements and Paving. Cleveland, O.: The Draftsman. Paper; 5¼ × 9 ins.; pp. 10. 20 cts.

This pamphlet consists principally of data and rules for computing quantities of materials in brickwork, masonry, mortar and concrete. We note one typographical error, the weight of granite being given as 107 lbs. per cu. ft.

There is nothing to indicate that bricks are made in many sizes aside from the standard size given. The same criticism holds true of the paving brick data. There are a few curious as well as erroneous sentences, such as this: "Lime and sand never increase the quantity of stone or concrete." A 1:2:5 concrete is said to require 1.35 bbls. of cement per cu. yd.; while a 1:3:5 concrete requires only 1 bbl. per cu. yd. Both of these statements cannot be correct. Nothing is said as to the size of the cement barrel in either case.

CAPE SOCIETY OF CIVIL ENGINEERS.—Minutes of Proceedings. Vol. II. Second Session, 1904. Cape Town, Cape Colony: The Society. Flexible cloth; 8½ × 10¾ ins.; pp. 66; illustrated.

Papers which may be noted are: "The Selection of Plant for the Construction of Engineering Works," by R. W. Newman, Assoc. M. Inst. C. E.; "Materials for Bridge Construction in Cape Colony," by Wm. Westhofen, M. Inst. C. E.; and "The Destruction of Timber on the West African Coast by Marine Wood-borers," by Frank W. Waldron, Assoc. M. Inst. C. E. Other papers deal with mineral exploration, road locomotion, harbors, and bridge construction.

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A Digest of the Evidence Presented to the Royal Commission on Sewage Disposal.

THE SEWAGE PROBLEM.—A Review of the Evidence Collected by the Royal Commission on Sewage Disposal. By Arthur J. Martin, Assoc. M. Inst. C. E., London: The Sanitary Publishing Co., Ltd. New York: D. Van Nostrand Co. Cloth; 5¼ × 7½ ins.; pp. 363. 8s. 6d. net; American price, $3.50 net.

Hearty thanks are due the author for the great service he has rendered engineers and sanitarians in digesting and classifying the evidence collected by the Royal Commission on Sewage Disposal. As the author states, the two volumes of evidence include 16,297 questions and answers, filling 821 pages. The same subjects were necessarily brought up and dropped many times during the examination, and, though the author does not mention it, much of the testimony was repeated and much was of little value. Besides the two volumes, of testimony, the author has made use of the twelve other blue books issued by the Commission, and also of the reports of previous commissions and of other printed matter. It should be added that the compilation and comment was completed before the publication of the five blue books on land treatment, but some use of these was made during the proof reading, and they receive more extended consideration in an appendix.

In his introductory chapter the author first cites the appointment of the Commission in May, 1898, and the "term of reference," or statement of the questions it was to consider. The commission of nine members includes two engineers, two medical officers of health, a professor of physiology and a professor of chemistry, the chairman of the sewerage committee of the city council of Leeds, a representative of the Mersey and Irwell Joint Committee, and an earl. The committee was instructed to inquire and report on efficient means of sewage disposal, on the rules to be adopted in selecting a method in cases where more than one method of treatment is available, and on desirable recommendations. After these statements, the author reviews the conclusions of former commissions, and outlines the attitude of the Local Government Board. He shows how the insistence of the board on the application of sewage to land, regardless of the character of the land, or of the treatment of sewage by other means, caused deadlocks between the board and local authorities, and retarded the prevention of stream pollution, besides giving rise to useless expenditures in many instances and causing a general protest against the rulings of the board. It is largely because of this protest that the Royal Commission was appointed to determine, in reality, whether the newer processes of treatment, now known as septic tanks, contact beds and percolating filters, could be relied upon without recourse to land.

For the benefit of the uninformed, it may be stated that Mr. Martin has been closely identified with the introduction of the septic tank, generally coupled, where further treatment is necessary, with contact beds. His digest bears evidence of an earnest attempt to present the weight of testimony for and against all of the processes of sewage treatment, both old and new, and in this he appears to have been successful. His own comments, we think, make clear his personal predilection. This is not a matter for surprise or condemnation, although perhaps it might have been well had the author stated briefly in his preface just what his relation to the septic tank and contact beds had been.

Coming now to the digest itself, the subjects are arranged as follows: Land treatment and the unsuitability of some lands for the purpose; chemical precipitation, the principles of the bacterial processes, the need for preliminary treatment, the cultivation tank, and the septic tank, and comparative values of preliminary processes; final treatment, contact beds, percolating filters (called here straining and trickling); filtering material; comparisons of contact beds with trickling filters and of filters with land treatment; other aspects of the problem; supplementary reports on land treatment, and the present outlook. A chronological summary, a list of the reports issued by the present commission, and indexes of witnesses and of subjects complete the volume.

It may be explained here that although the Royal Commission on Sewage Disposal was appointed seven years ago it has not yet issued its final report, and that, owing to delays in issuing the reports thus far made, the evidence digested by Mr. Martin is now a number of years old. Thus far, the most significant conclusions of the commission are that a non-putrefying effluent, fit to discharge into *some* streams, can be obtained without land treatment; that there should be a central authority to control stream pollution, and also one to safeguard the public against sewage-contaminated shell fish; that trade wastes may be admitted to public sewers and treated with domestic sewage; and that, with suitable land and proper management, good results can be secured by land treatment.

Of the nomenclature employed in the book, for most of which Mr. Martin is not responsible, it may be said that some is strange and some seems open to question. Thus the commission substitutes "land filtration" for the time-honored and classic term "intermittent downward filtration," and "surface irrigation" for "broad irrigation." Both the old and new terms apply chiefly, if not wholly, to variations in sewage farming, and as such may perhaps be justified. There still seems to be a use for the term "intermittent downward filtration," or merely "intermittent filtration," but perhaps this is more true in America than in Great Britain.

To distinguish what we prefer to call percolating filters from contact beds, Mr. Martin substitutes "flow" for percolating. He then divides flow filters into "streaming" and "trickling." In streaming filters the liquid "flows freely," and in trickling filters it "percolates in thin films in contact with air." In the way of further definition Mr. Martin quotes Mr. W. J. Dibdin, as follows:

> I may explain what I mean by streaming. That is, the beds are then worked in the same manner as that in which a water company works its filters.

Further on Mr. Martin says:

> Trickling filters differ from streaming filters in that the effluent is not allowed to flood the surface of the beds, but is showered or sprayed on to them. This in some cases takes place continuously for several hours at a time, while at others the filters are fed intermittently.

Are not Mr. Dibdin's and Mr. Martin's streaming filters practically identical with the intermittent downward filters of the earlier commission on sewage disposal and those now so extensively used in Massachusetts and elsewhere in America? If so, it will not be easy to get the new term into current use in either country. The name percolating filters seems to be quite as good as trickling filters, and is, we believe, in more common use.

These questions of nomenclature do not materially lessen the great merits of the book before us. They are raised chiefly because, without discussion, a common terminology for sewage treatment cannot be formed, and without it either confusion or a needless multiplication of explanatory words will result.

In conclusion, we wish to commend once more this review of British ideas and practice, and to add that the book has been made up in a form handy for reading or for reference.

PROCEEDINGS OF THE OHIO ENGINEERING SOCIETY.—Twenty-fifth and Twenty-sixth Annual Meetings, 1904-1905. Columbus, O.: The Society (E. G. Bradbury, Secretary, 85 N. High St.) Paper; 6 × 9 ins.; pp. 231; illustrated. 50 cts.

ILLINOIS SOCIETY OF ENGINEERS AND SURVEYORS.—Proceedings at the Twentieth Annual Meeting, Held at Chicago, Illinois, January 18, 19 and 20, 1905. Chicago, Ill.: The Society (E. E. R. Tratman, Secretary, 1636 Monadnock Block). Paper; 6 × 9 ins.; pp. 210; illustrated. 50 cts.

The Ohio Engineering Society is a welcome change in name from the Ohio Society of Surveyors and Civil Engineers. The proceedings contain papers on concrete, plain and reinforced, roads, bridges, sewage disposal, railway construction, street railway tracks and pavements, the reservoir system at the head of the Mississippi River, and a concrete mausoleum. The latter was designed and built by Mr. J. B. Strawn, of Salem, O.

The Illinois proceedings contain a group of papers on surveying, drainage, plain and reinforced concrete, besides papers and reports on bridges, paving, water meters, wells and pumps, water filtration, and the park system of Chicago.

THE MICHIGAN ENGINEER.—Containing the Pr[illegible] ings of the Michigan Engineering Society for [illegible] Climax, Mich.: The Society (F. Hodgman, Secre[illegible] Paper; 6 × 8½ ins.; pp. 150; illustrated.

Forestry, water supply, surveying, bridge [illegible] struction and electric railways, cost figuring [illegible] the Pintsch suction gas producer are among [illegible] subjects treated in this report.

IOWA ENGINEERING SOCIETY.—Proceedings of [illegible] Seventeenth Annual Meeting, Held at Iowa City, I[illegible] Jan. 11, 12, 13, 1905. Iowa City, Ia.: The So[illegible] (B. J. Lambert, Secy.-Treas., Iowa City). Paper; [illegible] 8½ ins.; pp. 188; folding and other plates and [illegible] illustrations. 50 cts.

The papers and discussions included in this [illegible] port deal with water supply, sewerage, paving, [illegible] ment and concrete, reinforced concrete, rail[illegible] shops, water power and other subjects.

BROOKLYN ENGINEERS' CLUB.—Proceedings for 19[illegible] Constitution and By-Laws and Catalogue of Refe[illegible] Works added to the Library during the year. Brook[illegible] N. Y.: The Secretary, 197 Montague St. Cloth; 6 [illegible] ins.; pp. 210; illustrated. $2.

Seven papers are here included, dealing with [illegible] hydrographic surveys, rail joints and pavements, [illegible] gas corporations and consumers, movable bridges, [illegible] the power system of the Brooklyn Rapid Transit [illegible] Co., terra cotta arches, and a reinforced concrete [illegible] arch in Brooklyn.

THE SECOND ANNUAL SANITARY CONFERENCE OF THE HEALTH OFFICIALS OF CONNECTICUT.—Under the auspices of the State Board of Health. New Haven, Conn.: Pub. Doc. Paper; 5¾ × 8¼ ins.; pp. 100; illustrated.

Among the papers in this report are: "The Sewage Problem in Connecticut," by F. L. Ford; "Septic Tank at Manchester, Conn," by T. H. McKenzie; "British Sewage Works," by M. N. Baker; and "The Use of Copper Salts in the Purification of Public Water Supplies," by Prof. H. E. Smith.

THE ACTIVITIES OF CIVIC ORGANIZATIONS FOR MUNICIPAL IMPROVEMENT IN THE UNITED STATES.—A Symposium. Introduction.—The Co-Ordination of Civic Effort. By Clinton Rogers Woodruff, Esq. A Description of National and Local Civic Organizations. By A. Prescott Folwell, John MacVicar, and Others. (Reprinted from The Annals of the American Academy of Political and Social Science for March, 1905.) Philadelphia, Pa.: The Academy. Paper; 6¾ × 9½ ins.; pp. 157 to 190. 50 cts.

These outlines of the work of national and local organizations devoted to municipal improvements contain much of interest and suggestion.

NOTES ON

BRITISH REFUSE DESTRUCTORS

With an Introductory

COMPARISON OF BRITISH REFUSE DESTRUCTORS AND AMERICAN GARBAGE FURNACES

By M. N. BAKER, Ph. B., C. E.

The original notes were taken on a recent trip abroad, during which about twenty destructors in British and Continental cities were visited. The notes and editorial comments were published in Engineering News of April 13, 20 and 27, 1905.

At nearly all the destructors visited the heat from the burning refuse was being utilized to generate electricity or to pump either sewage or water. Some of the destructors were combined with sewage purification works and some with night soil works, and at most of the cities the clinker residue was being used for making concrete, mortar, roads or sewage filter beds. These and other interesting points, including rates of wages and tenure of office, are set forth in the notes.

The destructors described are located in the London boroughs of Shoreditch, Wandsworth and Battersea, the city of Westminster, and in Birmingham, Rochdale, Aldershot, Salisbury, Watford, Accrington, York, Bournemouth, and Bradford, England; Glasgow, Scotland; Hamburg, Germany, and Zurich, Switzerland.

Paper; 4½ x 7 ins.; pp. 62; three illustrations.

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THE ENGINEERING NEWS PUBLISHING CO.
220 Broadway New York City

Descriptive Geometry for Students.

Reviewed by Prof. Henry S. Jacoby.*

DESCRIPTIVE GEOMETRY.—For Students of Engineering.—By James Ambrose Moyer, S. B., A. M., Instructor in Descriptive Geometry in Harvard University. Second Edition. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 × 9¼ ins.; pp. 198; 128 figures. $2.

The second edition of this book follows the first in about one year; it is far more than a slight revision, and is issued by another publisher. It is practically a new book. The text has been more than doubled, and the number of diagrams increased from 33 to 77, while some additional illustrations are inserted without numbers. The text is placed on the left-hand pages, and the diagrams, instead of being massed at the end of the volume, as in the former edition, are placed on the right-hand pages, the space not thus used being available for notes by the student.

The elementary principles and notation are followed by the chapter of problems relating to the point, line and plane, which extends to the middle of the book. The notation is a slight modification of the modern system, and is easily remembered by the student. The problems of the point, line and plane are arranged in a more logical order than the traditional one, and in this respect the work represents a decided step in advance. The progressive application of each element serves to fix it firmly in mind before the next element is introduced. For instance, a number of problems are given in which the traces of a line are used before considering the length of a line, which in many books on this subject directly follows the determination of traces.

Another commendable feature consists of numerous graded exercises for the student, in which the given points are definitely located by their three co-ordinates as in analytic geometry. When the given data are not fixed in this manner, experience shows that the student frequently reproduces the diagram in the text by depending upon memory rather than upon the principles involved in the construction, while in other cases time is wasted by parts of required drawing extending beyond the limits of the standard sheet adopted for class-room work. A number of these examples show the practical applications of descriptive geometry, and thereby incite the student's interest in the subject.

About two-thirds of the second half of the book is devoted to problems relating to planes tangent to solids, and to the intersection and development of solids or surfaces. A considerable number of practical examples are introduced in the latter chapter. The three remaining chapters, on shades and shadows, warped surfaces, and perspective, are very brief, but the material given is selected with care. A half-tone picture of a hyperbolic paraboloid shows a type of illustration that could be advantageously introduced in books on descriptive geometry, even though the students may have access to a set of models. It is hoped that an index may be added in the future to facilitate reference.

As a whole, the book is well adapted to the needs of engineering colleges, and in a number of important features is the most satisfactory one now available.

*College of Civil Engineering, Cornell University, Ithaca, N. Y.

DIRECTORY OF DIRECTORS IN THE CITY OF NEW YORK. New York: The Audit Co. Cloth; 5½ × 8 ins.; pp. 968.

Besides the alphabetical list of directors, with offices held and street addresses, this volume contains an appendix giving names, officers and directors or trustees of banks and trust companies, insurance, safe deposit and guarantee companies, transportation, telegraph, telephone and express companies, and manufacturing and miscellaneous companies in New York City. The usefulness of the volume is generally acknowledged.

Literary Magazines.

Quite an array of articles on engineering and municipal topics appears in the "Review of Reviews" for May. There are brief articles on the Simplon tunnel, on "The First Turbine Liner to Cross the Atlantic" (the "Victorian"), a sketch of Mr. Theo. P. Shonts, the new head of the Panama Canal Commission. All these are illustrated, and so are "Harrisburg's Civic Awakening," by J. Horace McFarland; "The Grouping of Public Buildings at Cleveland," and "Farming City Lots." A further municipal article presents the status of municipal ownership of street railways at Chicago. The "World's Work" treats of "The Kansas Oil Fight," trade schools, and strike breaking, and has a well-illustrated article on "Electricity Transforming Traffic." The frenzied finance article in "Everybody's" this month is on Amalgamated Copper. The "Beef Trust" comes in elsewhere for description as the greatest trust in the world. The evils of certain classes of people are still further shown up in the same magazine by an article on "West Coast Land Grafters." Every one his own weather forecaster might have been the title of the Hon. Rollo Russell's "Scientific Local Weather Forecasts" in "The Contemporary Review" for April. This desirable object is to be attained, not by "instrumental readings," but by "the signs in the atmosphere which are open to every sailor, farmer and country laborer"—but we may add that sailors, farmers and laborers do not use the same names for the signs as are found in the article.

An interesting analytical discussion of "What College Professors Should Be Paid" may be found in the "Atlantic." In "Scribner's" there is a strikingly illustrated article called "Over Night at the Edge of the Grand Canyon," and some very pleasing engravings accompany a paper on "The Awakening of the Trees." From "McClure's Magazine" one may learn through Lincoln Steffens some of the bad things about the government of New Jersey.

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XXIX—Coal Stores and Coal Silos.
XXX—High-level Cranes. Index.

D. VAN NOSTRAND COMPANY, Publishers and Booksellers, 23 Murray and 27 Warren Streets, NEW YORK

All things considered, perhaps the most notable contribution to the magazines of the month, from an engineering viewpoint, is "The Arc-Light," by Mr. Charles F. Brush, in the "Century." In the same magazine Dr. Anita N. McGee shows how "The Japanese Save Lives" by their well-organized medical and sanitation corps of the army and navy. The United States might learn much from Japan in this particular.

Publications Received.

AMERICAN CARPENTER AND BUILDER.—William A. Radford, Editor. Published monthly. Vol. I., No. 1. Chicago: American Carpenter & Builder Co., 196 Fifth Ave. Paper; 9 x 12 ins.; pp. 68; illustrated. $2 a year.

THE ARCHITECTS' AND BUILDERS' DIRECTORY OF DETROIT.—Architects, Builders, Contractors, Plumbers, Masons and Supply Houses, Etc., New York: Frank A. Barrett, 458 Fourth Ave. Paper; 4½ x 6 ins.; pp. 129. 50 cts.

ARMY LIST AND DIRECTORY.—Officers of the Army of the United States. April 20, 1905. Washington, D. C.: Pub. Doc. Paper; 7 x 10½ ins.; pp. 80.

THE AUSTRALIAN OFFICIAL JOURNAL OF PATENTS.—Proceedings of the Commonwealth of Australia Patent Office. No. 1; Jan. 24, 1905. Melbourne: Government Printing Office. Paper; 7¼ x 10½ ins.; pp. 13. Weekly at 6d. a number or 25s. a year.

BULLETINS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 6 x 9 ins.

No. 242: Geology of the Hudson Valley, between the Hoosic and the Kinderhook. By T. Nelson Dale. Pp. 63; three plates and 17 text illustrations.

No. 244: Contributions to Devonian Paleontology, 1903. By Henry Shaler Williams and Edward M. Kindle. Pp. 144; four plates, three text illustrations and four folding charts.

No. 246: Zinc and Lead Deposits of Northwestern Illinois. By H. Foster Bain. Pp. 56; five plates and three figures.

No. 249: Limestones of Southwestern Pennsylvania. By Frederick G. Clapp. Pp. 62; seven plates.

No. 252: Preliminary Report on the Geology and Water Resources of Central Oregon. By Israel C. Russell. Pp. 138; 24 plates and four text illustrations.

No. 253: Comparison of Wet and Crucible-Fire Methods for the Assay of Gold Telluride Ores. With Notes on the Errors Occurring in the Operations of Fire Assay and Parting. By W. F. Hillebrand and E. T. Allen. Pp. 30; nine tables.

No. 259: Report on Progress of Investigations of Mineral Resources of Alaska in 1904. By Alfred H. Brooks and Others. Pp. 196; three plates and 10 text illustrations.

CENSUS OF MANUFACTURES: 1904. MICHIGAN.—Bulletin 18, Bureau of the Census. S. N. D. North, Director. Washington, D. C.: Pub. Doc. Paper; 9 x 11¾ ins.; pp. 35.

CENSUS OF THE PHILIPPINE ISLANDS: 1903.—Gen. J. P. Sanger, U. S. A., Director. Washington, D. C.: Pub. Doc. Paper; 5¾ x 9 ins.

Bulletin 1: Population by Islands, Provinces, Municipalities, and Barrios, Taken in the Year 1903. Pp. 100.

Bulletin 2: Climate. By Rev. José Algué, S. J., Director of the Philippine Weather Bureau. Pp. 103; two folding maps, 27 plates and 51 tables in the text.

Bulletin 3: Volcanoes and Seismic Centers. By Rev. M. Saderra Maso, S. J., Assistant Director of the Philippine Weather Bureau. Pp. 80; 15 illustrations in the text.

A CHAPTER ON LETTERING.—With Samples of Figures, Headings, Initials, Scrolls and Titles. Cleveland, O.: The Draftsman. Paper; 6 x 9 ins.; pp. 25. 25 cts.

CONTRIBUTION TO THE BIOCHEMISTRY OF SEWAGE PURIFICATION; THE BACTERIOLYSIS OF PEPTONES AND NITRATES.—By Stephen DeM. Gage. (Reprinted from The Journal of American Chemical Society, Vol. XXVII, No. 4, April, 1905.) Paper; 6 x 9 ins.; pp. 327 to 363; five tables.

THE CURRENTS AT THE ENTRANCE OF THE BAY OF FUNDY AND ON THE STEAMSHIP ROUTES IN ITS APPROACHES OFF SOUTHERN NOVA SCOTIA.—From Investigations of the Tidal and Current Survey in the Season of 1904. W. Bell Dawson, M. A., D. Sc., F. R. S. C., M. Can. Soc. C. E., Engineer in Charge. Ottawa, Canada: Pub. Doc. Paper; 6¼ x 9¾ ins.; pp. 17; tables, and one folding map.

EARTH AND ROCK EXCAVATION.—A Practical Treatise. By Charles Prelini, C. E., Arthor of "Tunneling." New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 6¼ x 9¼ ins.; pp. 357; 167 figures in the text; $3 net.

FEDERAL, STATE, COUNTY, TOWNSHIP AND MUNICIPAL OFFICERS.—Ohio, 1905. Springfield, O.: Pub. Doc. Paper; 6¼ x 9¼ ins.; pp. 498.

HIGH SPEED TOOL STEELS.—By L. P. Breckenridge. Circular No. 1 of the University of Illinois Engineering Experiment Station. University of Illinois Bulletin No. 7 (Vol. II.). Urbana, Ill.: The University. Paper; 6 x 9 ins.; pp. 9; seven tables.

THE LIMESTONES OF ONTARIO.—By Willet G. Miller, Provincial Geologist. Part II. of the Report of the Bureau of Mines, 1904. Thos. W. Gibson, Director. Toronto, Ont.: Pub. Doc. Paper; 6½ x 9¾ ins.; pp. 143; illustrated.

LOCOMOTIVE TESTING PLANT AT THE LOUISIANA PURCHASE EXPOSITION.—St. Louis, Mo., 1904. Bulletin No. 4, Tests of Pennsylvania Railroad Consolidation Locomotive No. 1499. Philadelphia: Pennsylvania Railroad Co. Paper; 6 x 9 ins.; pp. 82; folding and other diagrams, and tables. 50 cts.

MARINE ENGINES AND BOILERS.—Their Design and Construction. A Handbook for the Use of Students, Engineers, and Naval Constructors. Based on the Work, "Berechnung und Konstruktion der Schiffsmaschinen und kessel," by Dr. G. Bauer, Engineer-in-Chief of the Vulcan Works, Stettin. Translated from the Second German Edition by E. M. Donkin and S. Bryan Donkin, Assoc. M. Inst. C. E. Edited by Leslie S. Robertson, M. Inst. C. E., M. Inst. M. E., Secretary to the Engineering Standards Committee, Author of "Water Tube Boilers," and Editor of M. Bertin's "Marine Boilers." New York: The Norman W. Henley Publishing Co. London: Crosby Lockwood & Son. Cloth; 6 x 9½ ins.; pp. 744; many tables, and 535 figures, mostly in the text. $9 net.

MACHINE TOOLS AND WORKSHOP PRACTICE.—For Engineering Students and Apprentices. By Alfred Parr, Instructor in Fitting and Machine Shop, and Forge, University College, Nottingham. With an Introduction by William Robinson, M. E., M. Inst. C. E., Professor of Engineering, University College, Nottingham. London, New York and Bombay: Longmans, Green & Co. Cloth; 5¾ x 9 ins.; pp. 444; 510 illustrations, mostly in the text. $4.

THE MECHANICAL HANDLING OF MATERIAL.—Being a Treatise on the Handling of Material such as Coal, Ore, Timber, &c., by Automatic or Semi-Automatic Machinery, Together with the Various Accessories Used in the Manipulation of Such Plant; also Dealing Fully with the Handling, Storing and Warehousing of Grain. By George Frederick Zimmer, Assoc. M. Inst. C. E. New York: D. Van Nostrand Co. London: Crosby Lockwood & Son. Cloth; 7½ x 10½ ins.; pp. 521; 542 figures, mostly in the text. $1 net.

MECHANICS OF AIR MACHINERY.—By Dr. Julius Weisbach and Professor Gustav Hermann. Authorized Translation, with an Appendix on American Practice by Amasa Trowbridge, Ph. B., Adjunct Professor of Mechanical Engineering, Columbia University. New York: D. Van Nostrand Co. Cloth; 6 x 9¼ ins.; pp. 206; two folding plates, and 91 figures in the text. $3.75 net.

THE METRIC FALLACY.—A Lecture delivered at Cornell University March 17, 1905. By Frederick A. Halsey. New York: The National Association of Manufacturers of the United States of America (170 Broadway). Paper; 6 x 8½ ins., pp. 24.

MINING BUREAU OF THE PHILIPPINE ISLANDS.—Reports for 1902-3 and 1903-4. H. D. McCoskey, Chief. Manila, P. I.: Pub. Doc. Paper; 6 x 9 ins.; (1) pp. 16 and (2) pp. 44, with 13 plates and two folding maps.

THE MODERN ASPHALT PAVEMENT.—By Clifford Richardson, Director, New York Testing Laboratory, Long Island City. N. Y. New York: John Wiley & Sons. London: Chapman & Hall, Ltd. Cloth; 6 x 9 ins.; pp. 580; tables, and 32 figures in the text. $3.

ON TYBEE KNOLL.—A Story of the Georgia Coast. By James B. Connolly, Author of "The Seiners," etc. New York: A. S. Barnes & Co. Cloth; 5 x 7¾ ins.; pp. 285; illustrated. $1.25.

ORIGIN OF THE CHANNELS SURROUNDING MANHATTAN ISLAND, NEW YORK.—By William Herbert Hobbs. Bulletin of the Geological Society of America, Vol. 16. (Read before the Society Dec. 3, 1902.) Rochester, N. Y.: The Society. Paper; 6¾ x 10 ins.; pp. 151 to 182; one plate, and 24 figures in the text.

THE POCKET BOOK OF REFRIGERATION AND ICE-MAKING.—Edited by A. J. Wallis-Tayler, C. E., Assoc. M. Inst. C. E., Author of "Refrigerating and Ice-Making Machinery," "Refrigeration, Cold Storage and Ice-Making," etc., etc. Fourth Edition, Enlarged. New York: The Norman W. Henley Publishing Co. Cloth; 4½ x 7 ins.; pp. 184; tables, and 31 figures in the text. $1.50.

PROCEEDINGS OF THE THIRD CONVENTION OF WEATHER BUREAU OFFICIALS.—Held at Peoria, Ill., Sept. 20, 21, 22, 1904. Published by authority of The Secretary of Agriculture, under direction of Chief of the Weather Bureau. Washington, D. C.: Pub. Doc. Paper; 5¾ x 9 ins.; pp. 267; tables, and folding and other charts and figures, partly in the text.

PROFESSIONAL PAPERS, U. S. GEOLOGICAL SURVEY.—Charles D. Walcott, Director. Washington, D. C.: Pub. Doc. Paper; 9 x 11½ ins.

No. 32: Preliminary Report on the Geology and Underground Water Resources of the Central Great Plains. By N. H. Darton. Pp. 433; 70 plates, 18 text figures, and two folding maps in pocket.

PROPERTIES OF STEEL SECTIONS.—A Reference Book for Structural Engineers and Architects, Including Tables of Moments of Inertia and Radii of Gyration of Built Sections, Examples of Sections Selected from Monumental Structures, Unit Stresses, Safe Loads for Columns, Plate Girder Design, Design in Timber, etc., with Only Sufficient Text to Explain Their Application. By John C. Sample, C. E., M. Arch., Architectural Engineer, New York. New York: McGraw Publishing Co. Cloth; 6¼ x 9½ ins.; pp. 121. $3.

PROBLEMS OF THE PANAMA CANAL.—Including Climatology of the Isthmus, Physics and Hydraulics of the River Chagres, Cut at the Continental Divide and Discussion of Plans for the Waterway. By Brig.-Gen. Henry L. Abbot, U. S. Army, Retired. New York: The Macmillan Co. London: Macmillan & Co., Ltd. Cloth; 5¼ x 7¾ ins.; pp. 248; 34 tables, one folding map, and 15 figures in the text. $1.50 net.

RADIO-ACTIVITY.—By E. Rutherford, D. Sc., F. R. S., F. R. S. C., MacDonald Professor of Physics, McGill University, Montreal. Cambridge: The University Press. New York: The Macmillan Co. Cloth; 5½ x 8¾ ins.; pp. 399; 60 figures, mostly in the text. 10s. 6d.; American price, $3.50 net.

THE RAILROAD AND WAREHOUSE COMMISSION OF THE STATE OF ILLINOIS.—Thirty-fourth Annual Report. Railroads for the Year Ending June 30, 1904. Grain Inspection Department for the Year Ending Oct. 31, 1904. Office Expenses for the Year Ending Nov. 30, 1904. Springfield, Ill.: Pub. Doc. Leather; 6 x 8½ ins.; pp. 495; illustrated.

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THE SHADE TREES OF DENVER.—By W. Paddock and B. O. Longyear. Bulletin 96, February, 1905, The Agricultural Experiment Station of the Agricultural College of Colorado. Fort Collins, Colo.: The Experiment Station. Paper; 6 x 9¼ ins.; pp. 14; 13 plates.

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A STATISTICAL ACCOUNT OF AUSTRALIA AND NEW ZEALAND, 1903-4.—By T. A. Coghlan, Chief Statistician. Eleventh issue. Published by authority of the government of the State of New South Wales and of the Commonwealth of Australia. Sydney, New South Wales: Pub. Doc. Boards; 5½ x 8¾ ins.; pp. 1042; tables.

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